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CATALYSING A CONSTRUCTION PROJECT USING NOVEL SOFTWARE TECHNOLOGY

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Abstract. A nations' construction sector is an important sector of its economy. The same goes for the Nigerian Construction sector. Huge volumes of investment and capital expenditure from the central economy go into this sector of the economy in a bid to provide infrastructure for sustainable development. The construction industry is a driver for the economic growth of any nation. However, the Nigerian construction industry has consistently underperformed when compared with its potential for output. In an effort to identify the key causes for this massive underperformance and the Non value adding activities crippling the Nigerian Construction Sector (NCS), a comprehensive research was conducted. This research revealed that communication between stakeholders, ease of collaboration between project professionals on and off site, Inadequate scheduling of tasks as well as task monitoring systems and improper management of physical resources on site amongst other things are the major inhibitors to construction project success. The focus of the research was to develop a software that takes full advantage of a technologically based solutions to address this issue. The research conducted, informed the decision to build a modular web-based application that will be divided into five modules; each module addressing one of the five key issues identified as inhibitors to construction project success. In conclusion, the web application built was applied to the construction of a building within Canaan Land Ota. The results of this application showed improvement in construction efficiency, time savings and budget savings and overall project success with the use of the software.

Keywords: Construction, Nigerian Construction Sector, Communication, Collaboration, Task Management, Material Management, Budget Control, Document Control, Web Application.

1. Introduction

Tasks and procedures undertaken in construction are largely routine tasks that require little modification to suit the intended purpose, use case or design. The real challenge in construction is proper planning at the start and adequate and constant monitoring and control through the construction process. The better the monitoring and control employed in a construction, the more likely the project is to be successfully executed within the constraints of time, cost and scope.

There is a famous French saying that goes "if construction moves, everything moves". The secret behind the rise the economies of Japan/Germany/Europe after the ashes of WWII, is the rapid

advances made in their construction industries. It is therefore clear that the backbone of any developing Nation is its vibrant construction Industry. Nigeria is classified as a developing nation. In Nigeria huge amounts of money have been invested in the construction industry. In recent years about 70% of Nigeria's annual capital expenditure has been invested in the Nigerian Construction Industry. However, the NCS contributes only ~4% to our Nations GDP [1].

It becomes clear that it not an issue of how much money is put into the industry but necessary innovation of the old methods to bring about new results. "Insanity is doing the same thing over and over again expecting a different result "Albert Einstein.

The world today is advancing at an outstanding rate. Advances in technology have transformed our societies and the way we live in such a short period of time and will continue to transform our lives at an even faster rate. The spread and adoption of modern technologies are further catalyzed by the advent of its most notable proponent yet; the internet. As at 2012, only 28 million Nigerians where using the internet. A report from the NCC (Nigerian Communication Commission) shows that as at May 2018 103 million internet users where recorded in Nigeria. This presents a unique opportunity to software developers in Nigeria to build web-based software that are aimed at solving societal problems.

This study is aimed at discovering guiding parameters for the development of a web-based software for the management of construction projects throughout their life cycle. The lifecycle of a construction project is typically broken down in 6 key phases for any construction management project. These phases are:

i. Pre-project phase
ii. Planning and design phase
iii. Contractor selection phase
iv. Project mobilization phase
v. Project operations phase
vi. Project closeout and termination phase.

However, these phases can be further grouped into three important phases which are design, construction, and operation. The construction process is chronological between the design and operation phases [2]. The research and development focus of this study is on how the initiation, planning stages and execution of a construction project can be effectively and efficiently fast tracked.

2. Literature Review

Numerous researchers have attempted to dissect the issues that plague the Nigerian Construction Sector (NCS). In this section we shall be exploring the already existing works in this field of study with a view to proving solutions to the unique problems identified. We shall be doing so with a global perspective and a local focus.

2.1. Challenges Facing the Industry

By definition, A project involves all the actions that are geared towards achieving the goals in order to create a system complicated with specific characteristics in quality in within a given time boundary and given resources [3]. According to the authors of article [4], the Construction sector history in many countries comprises of projects that were not completed within significant time and cost constraints. Due to this there is a major problem in the time of project delivery and overruns in cost is a global concern and contributes largely to the productivity level, which is necessary for the sustenance and growth of any establishment, industry or nation [5].

2.2. *Construction Delays.* The Nigerian Construction Sector is laden with several challenges especially delay in project completion. While the author in article [6], on the one hand defined delay as time loss, the author of article [7] described delay as time overrun beyond the date of completion that the parties agreed upon for delivery of the project in a contract. The challenges associated with construction delay are not peculiar to Nigeria, but global in nature as countries like Ghana, Egypt, Iran, Vietnam, Indonesia,

Thailand, Palestine, Saudi-Arabia, Jordan, United Arab Emirate (UAE) to mention a few according to Abisuga, 2006 in article [8] are experiencing similar issues in their construction industries.

However, construction delay is more worrisome in Nigeria because seven out of every ten projects suffer delay in their execution, according to the research conducted by Odeyinka et al, 1997 in article [9] who alluded that seventy percent of projects surveyed in Nigeria suffered failure due to delay in their execution. These figures may have risen or reduced since 1977 due to urbanization, globalization and advent of technology. These delays result in time and cost overrun, disagreement, adjudication, lawsuit, and sometimes total abandonment [10]. This view is corroborated by Assaf and Al-Hejji, 2006 in article [7] who opined that time overrun is a major effect resulting from delays in projects completion. Abdul-Rahman et al, 2006 [11] further attributed increased time related costs, loss of productivity, late project completion, work disruption, third party claims and termination of contract to resultant effects of construction delays. It is important to properly categorize construction delays in order to provide a proper framework for finding reasons for the delay and to properly examine their effects.

Construction delays was grouped by the authors of aticle [12] into four categories viz a viz:

- project financing,
- economic
- natural conditions
- material supplies.

Ahmed et al [13], on the other hand grouped them into two major categories namely:

- *Internal delays*: This is instigated by the parties to the contract such as the client, designer, consultants and the contractor.
- *External delays*: This is instigated by non-parties to the contract including government action, material suppliers and act of God, etc.

2.3. Construction Management Software a panacea to some of the Industries Problems

The construction industrial sector is progressing more in the reliance on ICT to provide solutions to most of the tasking urgent challenges [14]. Hence, this means that the industry has to integrate Information and Communication Technology in most if not all of the processes carried out especially the enlisting of skilled labor. Using PMS as a tool for organizing and managing work has grown will continue to at a fast pace in all industries. One of which is at upmost importance is the construction industry [15]. Over time construction activities have become more and more complicated and specialized. Processes are distributed into smaller tasks and then dispersed amongst people. Therefore, due to complexity, the construction industry has opened to methods involving the use of ICT [16].

Different phases of construction can lead to problems, from unavailability of materials to over-stocking large quantities of materials, regardless of the importance of materials in construction and production [17]. Construction professionals are advised by Oladapo, 2006 in article [18] to take on the use of Information Communication Technology (ICT). Afolabi et al, 2018 [14] in their study focused on the author's consideration of the utilization of online technological platforms for the connection of required feasible skilled labor with their employers in construction. Not to be ignored is the huge savings of human lives and reduction of economic waste in developing nations like Nigeria if adequate monitoring tools are adopted to forecast and forestall the common frequencies of structural damages and collapse. [19][20][21]

3. Developing as a Web Based Application

The literature review has clearly highlighted the need for a new approach to undertaking construction projects in the Nigerian construction sector. The problems identified in the literature review, form the basis for the development of a web-driven solution proposed in this section. The methodology employed will be drawing on findings of the previous section to advance a framework for the development of the

intended prototype software. This section will take readers through a logical sequence of steps taken throughout the software development phase culminating in the prototype software.

3.1. Establishing Software Requirements

Wiegers and Beatty, 2013 in their book Software Requirements [22], described software requirements as a set of features or characteristics that a product must have in order to provide any form of value to the stakeholder or end user. Software requirements are a very crucial part of the successful development of any software [26]. They are often seen as the start of the software development life cycle. It was therefore imperative that at the start of the development of this software, specific features and uses of the software be clearly articulated: Here are list of said features:

1. Different professionals and personnel in construction site should have a regular common meeting ground via the platform.
2. One major requirement of the software is its ability to organize construction activities, processes and personnel in and out of site.
3. The system should allow for an efficient document management system that is organized with respect to the nature of the document (i.e. Architectural, Structural, Geotechnical and others).
4. The system should allow for efficient communication amongst all the stakeholders involved in a construction project.
5. Key planning processes on site should be catered for with use of the software.
6. Materials on site should be effectively managed to reduce wastage and improve efficiency.
7. The cost of all the construction processes must be efficiently and effectively managed so as to improve the productivity level with minimum cost implications.
8. Stakeholders involved in a project should be given a platform to effectively collaborate and team up to achieve stated goals.
9. All processes involving the use of the software should be of minimal difficulty to the average user.
10. The application should allow for hierarchal management where individuals on the top of the chart greater precedence over personnel under them.

Based on the functional requirements of the software, the following modules have been developed to cater for key activities during the initial and planning stages of a construction project:

i. Task Module
ii. Document Module
iii. Materials handling Module
iv. Budget Module
v. Messages Module

A task manager will be a core model to be incorporated into the system, the task manager will allow the registered professionals on the site to efficiently manage their activities and in turn delegate tasks to other professionals on site. The task manager is incorporated so as to solve the problem of activity management on site during construction.

The document module is a very essential part of the system to be incorporated. In most construction projects, time delay can be due to an ineffective management of construction documents on site, be it Architectural, Structural, Geotechnical, etc. When successful implemented, the document module is expected to organize the different documents needed daily on site efficiently as each document can be uploaded or removed by allowed registered users on the platform, in turn enhancing productivity on the construction site.

A web-based material planning and control tool would help to integrate the use of internet with a material planning and control technique ensuring that decision making is done quicker in a fast-paced world. Making a material planning and control system web based ensures that information regarding building materials can be accessed anywhere in the world. This feature is to be embedded with ecommerce for construction materials.

This feature is very essential to the overall economy of the project as a project exceeding its budget constraints will be very unlikely to the general success of the construction project. Before any main activity commences, the major project cost details are agreed on. It is therefore necessary that the cost level agreed upon is monitored and maintained.

A communication system will be needed for the software as the main definitions identified has to do with the problem for stakeholders to communicate before and during a construction project. An effective communication system will be developed to close the communication gaps between stakeholders of a project. Primary features of this communication module are: One-on-one Chat, Contact actual and presence listing, Store and forward (Offline messages), Personal Event Protocol (PEP) and Message typing specification, Multi-User Chat (MUC)—Group Chat, Privacy Setting and Account Spoofing and Message Archive Management (MAM).

3.2. Selecting a suitable Software Architecture

The peculiarities that the software described in the requirements, demands the need for a software architectural system that can be used for detaching the user interface from the database from which the user interface is fed data. This system will also need a set of unique instructions that will guide the processed flow of data from the database to the user interface as well as instructions guiding the systems responses to inputs from the user (construction professional) through the user interface. The Model View Controller (MVC) architecture detailed in Figure 1, suits the needs of such a system.

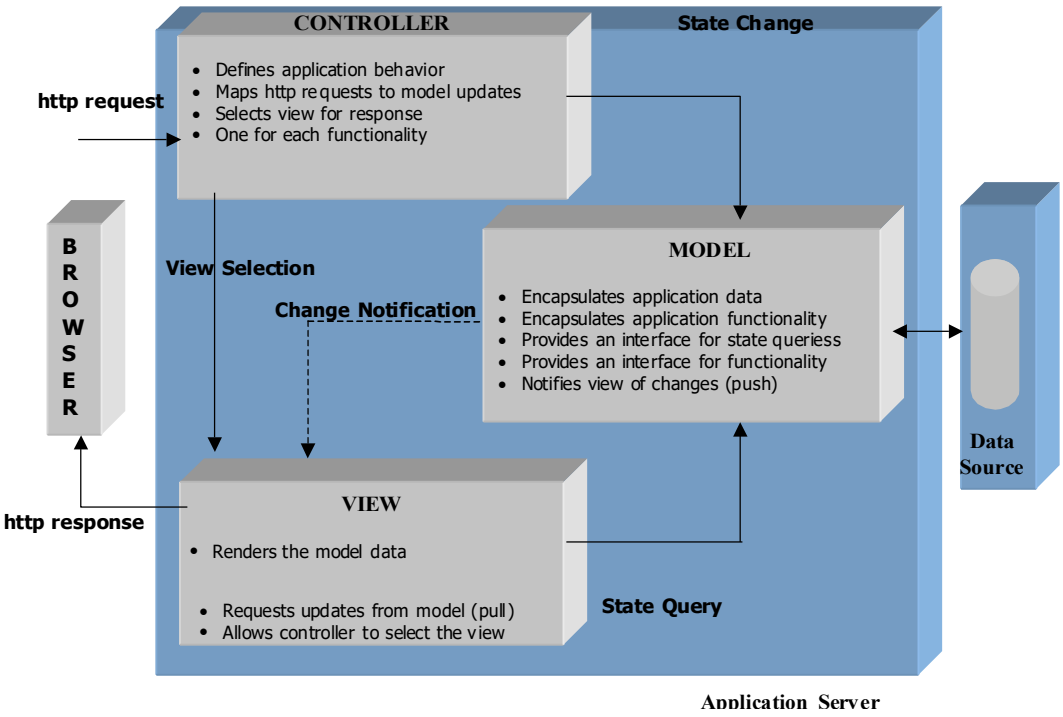

Figure 1: Model View Controller Architecture reprinted from Jacyntho et al, 2002. [24].

The Model contains all the set of instructions with the software runs on. Theses instructions may be static in nature or dynamic being able to adapt to unique use cases. The most significant part of the model is the application logic with contained business logic [25]. This distinct component within the model is the component that is entirely responsible for the behavior of the application as well as how the application stores data to the database. The model acts upon these instructions to manage data within the database and queries the database to retrieve information on demand from the other arms of the MVC architecture.

The View is the entity within the MVC triad that handles all of the images, graphics, text, audio, video, forms, buttons and other part of the application that the end user (construction professional) can interact with directly. In some instances, the view is referred to as the presentation layer as this is what the construction professional sees. The View interacts with both the model and the controller to generate what the construction professional interacts with when using the software. The view needs to be tightly linked with the model so as to remain conscious of the exact data stored in the database or the results of user (construction professional) queries to the software [22]. Nevertheless, the model need not be tightly linked to the view so that the view can be changed entirely without changes to the model. Such an implementation will be useful when changing between the modules to be developed in this software.

The Controller is the layer right beneath the view and is primarily responsible for handling the construction professional's direct input to the software. The controller receives the inputs from the view and interprets the input. Then it carries out of two actions:

1. Updates the model of a change in state by mapping the input from the construction professional to the model's operation for that particular input.
2. Updates the view by selecting a new view suitable for the input from the construction professional.

In the case of this software, the controller will be responsible for changing between the different modules of the software based on construction professional's demands. It will also be responsible for making sure the right input reaches the model so the information reaching the database or leaving the database to the construction professional is accurate.

3.3. Processes in the software coding.

During the final software development i.e. hardcoding of the designs, the Model View Controller architecture selected was the major influencer in the approach to the programming of the designs. To suit the system architecture and for a smoother development process, the programming process where divided into two major stages.

- Frontend Development
- Backend Development

The MVC architecture presented the opportunity to make this division in the development process with no damaging consequences to the functionality of either front end or backend. This approach also afforded the developers more speed as both front end and backend development processes were carried out simultaneously.

3.3.1. Frontend Development. Front End development or client-side development is the craft of creating HTML, CSS and JavaScript for a webpage or web application in order to generate what the end user can see. [26]. The front-end development of the software product takes into account the fact that users of the internet use different web browsers that render HTML, CSS and JavaScript files differently so designs must be made in such a way that they are not misconstrued in different web browsers. Furthermore, modern web application users access web apps through different devices with different screen sizes. Any web application must be able to retain the integrity of its content and design regardless of the device accessing it.

3.3.2. Backend Development. Tolani, 2019 in a web publication [27] described backend development or server-side development as the writing of codes that instructs the computer systems that deliver the web application to its user on how to operate:

1. The databases that power the web application
2. The computers (servers) that handles user requests
3. The API that exchanges data between the database and the software accessing it
4. The Operating that runs the entire system

The backend of the software can be broken down four components which are the server, the database, the operating system, and the software itself. Here we shall be exploring two of these of four components before commencing to discuss the programming languages that power the back end of the construction management application that is developed at this phase of the study.

4. Implementation of the Web Based Construction Management Software modules.

Now the protype software has been developed as described in the previous section. The next step was to test out the software. A test project was chosen for the testing to demonstrate the functionally of the software. The project chosen was the Construction of a Power Transmission Station at Covenant University, Canaan Land, Ota, Ogun. This section will illustrate the steps taken in testing the software.

4.1. Implementation of the task module:

As the initiation part of the project commences, the admin (PPD director) has the obligation to add task globally (to everyone on the platform) or to specific professionals in the project. Here at the initiation stage of the project the admin adds task that deal with the site clearing initial activities, with a duration and details of the project, then professional partners involved in the project. This can be seen in Figure 1.

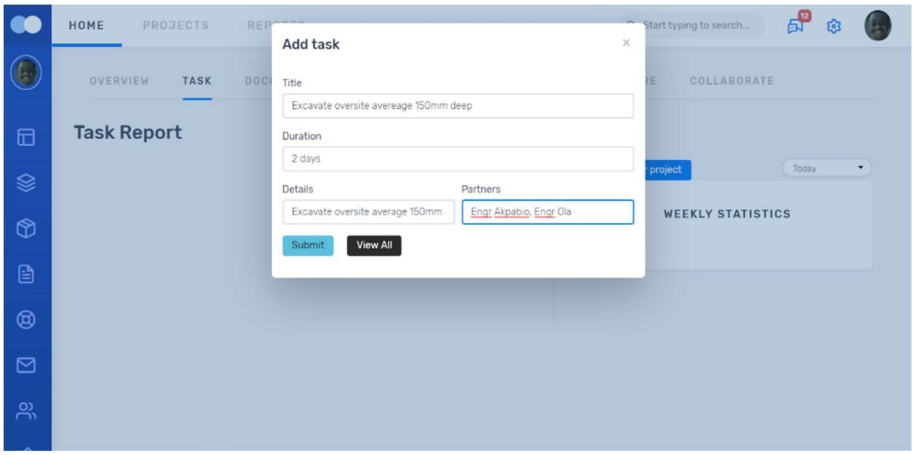

Figure 2: Application window showing the addition of task by the Admin.

After task have been assigned, they automatically appear on the task module page. Here it is seen that the tasks added at the beginning of the project appear at the top while the most recent task appear at the bottom, analysis of all the tasks was done by this method by the admin (project manager) to effectively manage tasks on the site as seen in Figure 2.

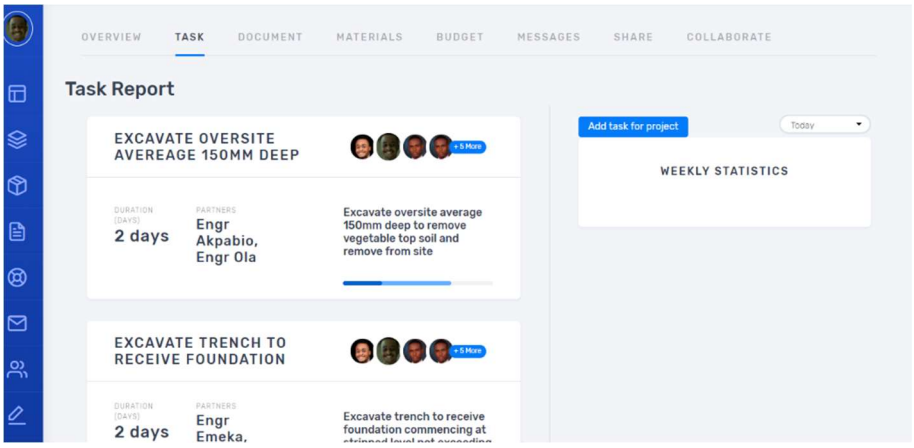

Figure 3: Application window showing added tasks on the platform.

As new task is defined and added on the platform, automatically all professionals on the site has access to the global task defined and specific task assigned. This automatically makes delegation and assigning more effective.

4.2. Implementation of the document module

For the document module, all the documents that were needed for the project were categorized and grouped in that manner for easy access on and off the site. Below the major categories represented were;

i. Architectural drawings
ii. Structural drawings
iii. Mechanical drawings
iv. Quantities documents
v. Accounting documents
vi. Highway drawings
vii. Laboratory drawings
viii. Survey reports

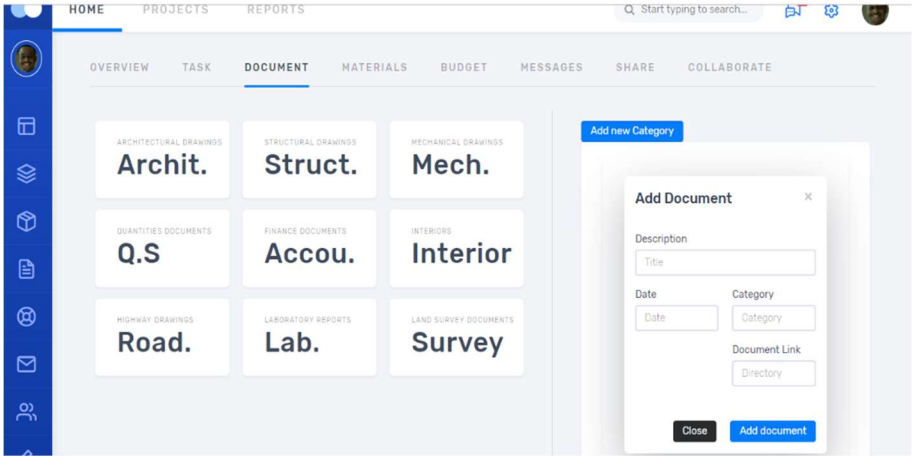

Figure 4: Application window showing the categories of documents added by the admin and other professionals.

After the document's module was clicked on, it therefore leads to a subpage that displays the drawings available in the specified categories which can then be assessed with ease.

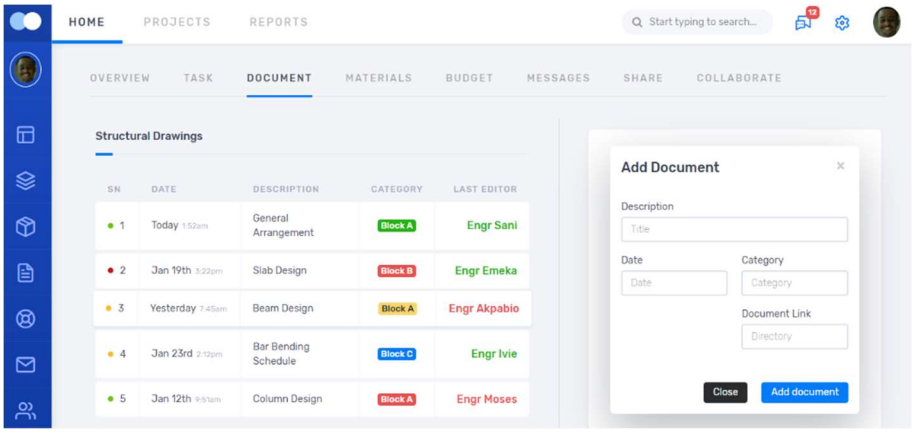

Figure 5: Application window showing the documents entered in a particular saved category

The document modules main task is in making effective the handling of documents on site which increases the quality of delivery as quality assurance and daily checks are made easier. This will also lead to a reduction in time as the less time in documents handling and checks will be made, this in turn directly affects the cost constraint of the project.

4.3. Implementation of the materials module

The first part shows the total quantities of materials that have been inputted into the system by the admin or professional (structural engineer, quantity surveyor). Under this then gives a broken-down illustration of the materials on site that have been inputted into the system. Major materials used in the site for the structural works are;

i. Cement
ii. Aggregate
iii. Sand
iv. Reinforcement.

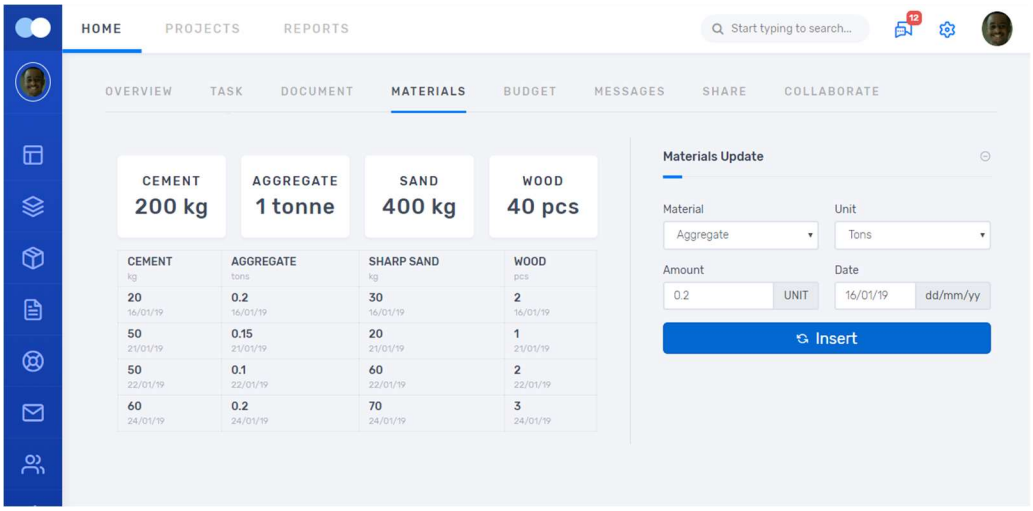

Figure 6: Application window showing the different materials on the site with emphasis on the availability of the materials

In the project, all the materials used on site have been summarized on the platform which in turn makes more effective materials handling which has a strong correlation to cost handling on site.

4.4. Implementation using Budget control module

The total cost of the construction component of the project was seen to be N 6,915,145. In the budget control module, the initial agreed price is set. Based on daily entries, a comparison is made with the initial cost set and eventually when approaching the figure set notifications will be given on how to best manage then resources available within the price given.

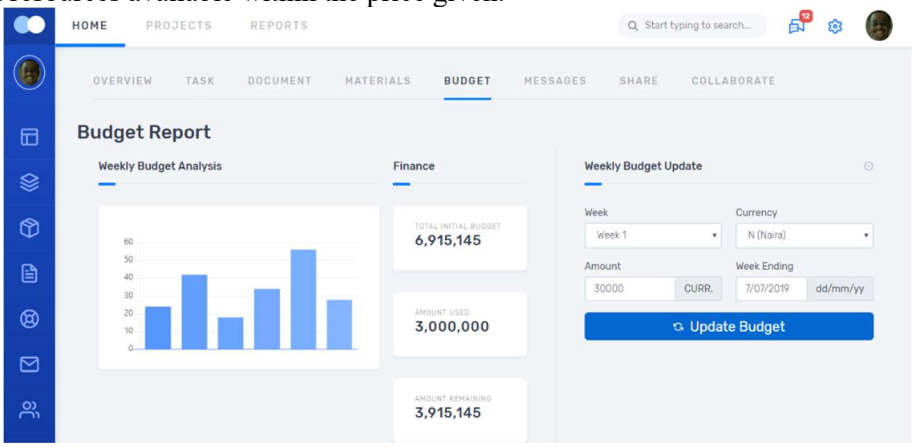

Figure 7: Application window showing the budget summary of the project

The first part of the budget module shows the current state of the project at the time of viewing showing the amount used, remaining and initial total cost. This will eventually lead to an effective cost management leading to a reduction in the cost on site and eventually the total time used on the site.

5. Conclusion

This study evaluated the potential impact that software specifically tailored for managing construction projects would have on the successful execution of a construction project in Nigeria. This was done with special focus on time, cost and quality of construction project's output. The project began by taking a good look at some of the major inhibitors of construction project success in Nigeria. The study went on determine the major causes of construction project delay in Nigeria. It was found that the top five issues that plague project delivery in Nigerian Construction Sector are Task Assigning and Task Monitoring, Document Control and Handing, Budget and Spending Control and Monitoring, Material Usage Monitoring, Internal Messaging and Communication. More research was then done to determine the past application of ICT in the Nigerian Construction Sector and their impact in order to set a precedence for the development for a web-based application software for tackling issues in the execution of construction projects. The study then developed a web application that was divided into six modules for addressing each key issue identified. These modules are the overview dashboard module, the task module, the documents module, the budget module, the materials module and the communications. The developed software was then simulated with a construction project in Canaan Land, Ota to determine its efficiency in addressing the issues. The selected construction project was the construction of Canaan City power house. It was found that by using the software developed, construction costs could be cut down and better managed and time of project delivery could have been fast tracked. The aim of the project was therefore achieved as the execution of the chosen construction project was catalysed using the software developed.

6. Recommendations

Innovations and further advancements in the construction sector in Nigeria need to be adhered to in order to increase and maintain high productivity levels on and off construction sites. The Nigerian construction sectors contribute less than 4% to the national GDP which is very low as compared to other nations, it is therefore the responsibility of the government and construction professionals to a keep to the standards of construction on and off site in order to genuinely minimize discrepancies and the application of the software and innovations will lead to maximum impact.

It is necessary to state that the government cannot do it all. The Nigerian construction professional also has a part to play in the growth and development of the industry. It is our industry after all. We must continue to search for new innovation in technology that can be applied in our Nigerian context. There are many major advances in construction methods occurring around the world. We owe it to ourselves and to future generations of Nigerian construction professionals to stay abreast of these advances so as not to fall too far behind. It my hope that someday in the near future, the Nigerian Construction industry will take her place as the major driver and enabler of economic growth in Nigeria.

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References

[1] Dantata S 2008 General Overview of the Nigerian Construction Industry *Sanusi Dantata* no. June 2007, 2008.
[2] Elzomor M and Parrish K 2016 Investigating Building Construction Process and Developing a Performance Index," in *Procedia Engineering*, 2016.
[3] Kagan P, Naumova A and Vilman Y 2016 The Problems of project management software implementation in construction corporations *MATEC Web Conf.*, 2016.
[4] Ameh O and Osegbo E 2011 Study of relationship between time overrun and productivity on construction sites," *Int. J. Constr. Supply Chain Manag.*, vol. 1, no. 1, pp. 56–67.
[5] Durdyev S and Mbachu J 2011 On-site labour productivity of New Zealand construction industry: Key constraints and improvement measures *Australas. J. Constr. Econ. Build.*, 2011.
[6] Majid I A 2006 Causes and effect of delays in Aceh construction industry," 2006.
[7] Assaf S A and Al-Hejji S 2006 Causes of delay in large construction projects *Int. J. Proj. Manag.*, 2006.
[8] Abisuga A O, Amusu O R O and Salvador K A 2014 Construction Delay in Nigeria : A Perception of Indigenous and Multinational Construction Firms Department of Building Technology *J. Emerg. Trends Econ. Manag. Sci.*, vol. 5, no. 3, pp. 371–378.
[9] Odeyinka H A and Yusuf A 1997 The causes and effects of construction delays on cost of housing project in Nigeria *J. Financ. Manag. Proj. Constr.*, vol. 2, pp. 31–41.
[10] Aibinu A A and Jagboro G O 2002 The effects of construction delays on project delivery in Nigerian construction industry," *Int. J. Proj. Manag.*, 2002.
[11] Abdul-Rahman H, Berawi M A, Berawi A R, Mohamed O, Othman M and Yahya I A 2006 Delay Mitigation in the Malaysian Construction Industry *J. Constr. Eng. Manag.*, 2006.
[12] Frimpong Y, Oluwoye J and Crawford L 2003 Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study *Int. J. Proj. Manag.* 2003.
[13] Ahmed S M, Salman A, Kappagantula P and Gollapudi D 2003 Delays in Construction : A Brief Stud of the Florida Construction Industr *Proc. 39th Annu. Conf. Clemson Univ.*, 2003.
[14] Afolabi A O, Oyeyipo O O, Ojelabi R A and Amusan A 2018 Construction Professionals' Perception of a Web-Based Recruiting System for Skilled Labour *J. Theor. Appl. Inf. Technol.*, vol. 31, no. 10, 2018.
[15] Liberatore M J, Pollack-Johnson B and Smith C A 2002 Project Management in Construction: Software Use and Research Directions *J. Constr. Eng. Manag.*, 2002.
[16] Klinc R, Turk Ž and Dolenc M 2010 ICT enabled communication in construction 2.0 *Pollack Period.*, 2010.
[17] Afolabi A, Fagbenle O and Mosaku T 2016 Characteristics of a Web-Based Integrated Material

Planning and Control System for Construction Project Delivery *Adv. Intell. Syst. Comput.*, vol. 445, 2016.
[18] Oladapo A A, "The Impact of ICT on Professional Practice in the Nigerian Construction Industry," *Electron. J. Inf. Syst. Dev. Ctries.*, vol. 24, no. 1, pp. 1–19, Apr. 2006.
[19] Ede A N, Akpabot A I, Olofinnade O M and Oyeyemi K D 2018 Forecasting the hazards of seismic-induced building collapse in Lagos-Nigeria through quality of reinforcing steel bars *International Journal of Mechanical Engineering and Technology* 9(8), pp. 766-775.
[20] Ede A N, Olofinnade O M and Sodipo J O 2017 *Use of building information modelling tools for structural health monitoring* Proceedings of the IEEE International Conference on Computing, Networking and Informatics, ICCNI 2017, pp. 1-4.
[21] Ede A N and Pascale G 2016 Structural Damage Assessment of FRP Strengthened Reinforced Concrete Beams under Cyclic Loads, *Materials Science Forum*, Vol. 866, pp 139-142. doi:10.4028/www.scientific.net/MSF.866.139
[22] Wiegers K and Beatty J 2013 *Software Requirements*, Third Edit. Microsoft Press,U.S.
[23] Fricker S A, Thuemmler C and Gavras A 2015 Requirements engineering for digital health," *Requir. Eng. Digit. Heal.*, no. October 2015, pp. 1–204.
[24] Jacyntho M D, Jacyntho M D, Schwabe D, Schwabe D, Rossi G and Rossi G 2002 A software architecture for structuring complex web applications *J. Web Eng.*, vol. 1, no. January, pp. 37–60, 2002.
[25] Madeyski L and Stochmialek M 2005 Quick review of approaches to architecture *Found. Comput. Decis. Sci.*, no. January 2005, pp. 49–60.
[26] Codesido I 2009 What is front-end development? *Theguardian.com*, Sep. 2009.
[27] Tolani K 2019 Backend Development; A Beginners Guide for 2019. [Online]. Available: https://learntocodewith.me/posts/backend-development/#javascript. [Accessed: 11-Jun-2019].