



(RESEARCH ARTICLE)



## Development and implementation of Building Site Information Management (BUSIM) for Nigeria Building Industry

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### Abstract

Overtime, building project delivery failures have been blamed on other factors except poor site management. Site management is considered by most building experts as off work-plan activities and as such attention is less giving to its process thereby creating delays in project. Also some others taken it serious have been shrouded with the manual process which in turn complicates the entire system. To solve this menace, the core objective of this paper is the development and deployment of cloud custom based building site information management system with emphasis on real time safety tracking, equipment maintenance tracking and management, materials management, site risk analytics and project progress report. The system is collaborative one and can be updated real time. To achieve the outcome, investigation into existing system was first carried out, as such, system failure were detected to upgrade the new system. However, in building the new system, suitable programming language that can give desired results were examined and Python 3.8 was utilized with Django 2.0.3 framework and Microsoft Visual Studio (MS VS) for the smooth running of programming languages. Due to Django having an ORM, supporting multiple databases, SQLite3 database, a simple database for lightweight applications was used. It is lightweight, fast for simple to medium applications. Results showed that BUSIM prototype app when applied not only will help in assessment of risk and real time overview for building site management, but will additionally improve the industry when adopted and applied to replace current manual process.

**Keywords:** Business; Building Site; Information System; Cloud Information Management System

### 1. Introduction

Site management which is the practical on-site monitoring and control of projects includes site assessment and layout, site mobilisation and on-site administration of both contract documents and activities makes up the major portion of the project entire process after planning phase[1]; and in Nigeria, Technically and administratively, construction site management is growing more complicated. Several difficult engineering and management issues arise on the job site, resulting in cost and time overruns in the majority of cases. The development of construction projects requires several stages and includes site activities in which inputs are turned into outputs by the combined efforts of operatives, machines, and professional construction workers, necessitating adequate planning[2].

Traditional construction site management approaches, on the other hand, are struggling to keep up with the current construction industry's information demands. While BIM technology has transformed the design process for many building and infrastructure projects[1], it is rarely utilised effectively during the construction site management phase [3]. Simultaneously, new technologies such as the internet of things, big data, cloud computing, virtual reality (VR), augmented reality (AR), unmanned aerial vehicles (UAVs), three-dimensional (3D) scanning, geographic information

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systems (GIS), and digital construction are becoming more common in construction, and these technologies must be combined with building site management systems to form a "organic" system for active management of construction site operations [2].

An intelligent site requires a highly organised data support system of collaborative information sharing with a complete account of employees, schedules, construction events, construction processes, decision-making analysis, and risk management [4]. It focuses on labour, machines, materials, processes, environments, countermeasures, and important parts of BIM in line with real time technologies [5].

The ideal interpretation of a "smart" site is to integrate these technologies with an intelligent site, hence this project provides a unique custom-based intelligent building site management system that mixes the internet and digital construction models [6]. The system may be utilised for better human resource management, allocation of machines and resources, material supervision, site access, quality control, safety, and other vital data. Decision-making may be based on real-time information, which will boost production and efficiency.

There is dearth of research on intelligent building site management system. Numerous researches such as [7];[8] and [9] reveal that in Nigeria, there has been minimal emphasis on the use of technology for construction site administration. They also noted that the current approach for construction site administration is manual. Some of the issues found include a time-consuming communication pattern in which building construction site managers are charged with bringing a client's vision and an architect's plan to life. Manually interpreting designs and incorporating changes is exhausting and time-consuming, so miscommunication is a common issue. Manual computation mistakes and the inability to create real-time project progress reports for simple accountability are further difficulties [10].

With straightforward software improvements, fast wireless networks, and cloud-based reporting access from anywhere in the globe, technology is quickly tackling these difficulties. Because communication is such an important aspect of this new technology, a web-based construction site management system that is tailored to specific needs is essential. The system will be the first of its type in Africa for Project Management, since it will handle records properly and in real-time, allowing all project stakeholders to get additional advantages from day-to-day site management operations. In reference to the problem statement, the main objective of this paper is the development and implementation of custom based site management system for Nigeria Building Industry.

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## 2. Review of Related Literature

Site management is a critical integrating process for attaining practical and purposeful results in areas where building or construction work is being done, whether within, adjacent to, or different from an existing occupied structure [11]. The site management staff is in charge of everything in general:

- Oversight of all operations on the premises [12].
- Production management for work carried out directly on site by the principal contractor [13].
- On-site supervision of subcontractors and specialists [14]

According to [15], a site management team considers three key characteristics to be "essential success factors" in evaluating their performance. These include meeting deadlines, staying under budget, and achieving the desired quality level. The hierarchy of functions and essential success factors should be considered when building a formal system for site administration.

If high-quality site administration is to be achieved, this is a must. The site management staff is also in charge of keeping accurate records of all major events that occur on site. The data should be correctly documented so that it may be promptly accessed for future use if needed. On building sites, site management entails a variety of tasks that transform raw materials into a final product [16].

The proper administration of the construction site is a must for any construction project. Essentially, all information gathered on site must be forwarded to the Head Office. It must be sent on time so that the information may be processed by the department receiving it. Wages, plant, and supplies received on a weekly basis; values, sub-contract details on a monthly basis; and communications and general information, as needed, will all be timed and calculated by the site management team [17].

On building sites, there are a variety of difficult engineering and managerial issues. These issues have an impact on time, money, planning, and specifications [18], and frequently result in errors, disagreements, and delays [17]. Many building site processes and practices, according to Dube, [19], have remained unchanged over time, and the same mistakes have been made. The issues discovered in site management practices, for example, may be divided into three categories: management and administrative challenges, technical and engineering issues, and communication problems on the job site.

By merging data from a meteorological centre and micro-meteorological station into a big data and cloud computing centre, conflict between weather conditions and engineering projects may be appropriately foreseen. It is feasible to assess the impact of changing environmental conditions on the building cycle and reschedule work activities in a timely manner. The results are sent to project managers along with real-time updates on the situation and recommendations. Project managers will be able to take actions and make decisions ahead of time, decreasing the influence of environmental conditions on the programme [5].

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### 3. Methodology

Here, we explore the methods chosen for developing an optimized BUSIM that is user friendly, collaborative, cost-friendly, improves the already existing manual processes while enhancing efficiency, effective on-site risk management, analytics report dashboard, speed, accuracy and timeliness in the execution and management of site construction processes in Nigeria.

A series of stages known as systems development methodology is used to construct any type of information system [20]. [21] definition of systems development approaches will be used in this research.

The system's functional requirements specify what it will accomplish, generally in terms of functions that it should be able to do. The system should be able to collect input data from the building site manager via forms, clean the data and save to a database in hierarchies which include company, project, specific tasks, costs, different management logging which include risk management, equipment maintenance management, cost management, performance reporting. The system is expected to display an analytics dashboard when the database is queried that does functional arithmetic on the overall performance of each project and track them in grouped order.

Non-functional requirements are descriptions of how a system should work. Non-functional requirements are important for how users view the finished system since they specify things like usability and performance. According to [22], non-functional criteria are grouped into four categories: usability, dependability, performance, and supportability.

In this work, we make use of Windows 10 operating system for local development, a Microsoft Corporation computer software product. This is because of the flexibility, affordability of use and popularity of use in Nigeria. Most site project managers make use of Windows OS while few work with Apple's Mac OS. This is chosen for easy compatibility in the offline version of the BUSIM app. For the online version, Linux operating system was used. Linux has advanced significantly, and as a result of its many useful features for businesses and home users, it has become one of the most widely used operating systems in the IT sector [23].

This system software patch is required for the smooth running of programming languages that depends on MS VS build tools. One of such is Python programming language. Without this installed and enabled in the windows operating system, the programming language compiler software will not work effectively.

Python is a versatile scripting language that have gained wide usage in industries and academia [24]. Used by big tech corporations like Facebook, Google, Apple, IBM and many other Fortune 500 tech companies across different industries. Python supports multiple usages including artificial intelligence, data science, big data, software development and myriads of other usages. We chose Python 3.8 as the version for the project due to the user-friendly code syntax, fast compiler, lightweight, flexibility, speed and wide community of usage. Our BUSIM will be a python based software and hence requires python to be installed in the computer.

These are list of libraries that add varying functionalities to the project. Libraries and dependencies are similar to people and relatives in that one is a stand-alone entity, while the other is a relational entity that is required for the former to function.

These libraries include boto3, botocore, dj-database-url, dj-static, django-appconf, django-multiselectfield, django-staticfiles, django-storages, docutils, gunicorn, jmespath, Pillow, psychopg2, python-dateutil, pytz, s3transfer, six, static3

Due to Django having an ORM, supporting multiple databases comes easy. In this project, we use SQLite3 database, a simple database for lightweight applications. It's lightweight, fast for simple to medium application.

### 3.1. BUSIM Structural Design

Structurally, BUSIM will have 4 component parts on development. These includes:

- The Core: Manages the pages, static and media functions
- The Manager: The underlying project framework that controls project settings
- The Projects: The app component that handles the different segments in a typical BUSIM like project name, costs, timelines, deliverables, tools, work status, completion status, reporting, risk and many more.
- The Register: Handles user registration, access and control

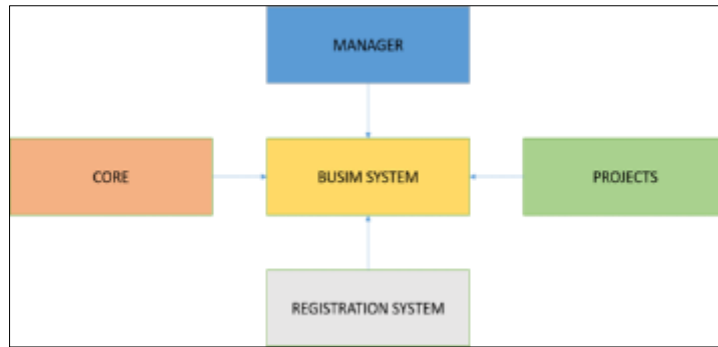


Figure 1 Structural Design of BUSIM app

### 3.2. The Functional Design for BUSIM

These are the different building site management functions the BUSIM system will carry out to replace the manual processes utilized in the target study area, Nigeria. Functional Design is a design concept that makes creating hardware and software devices, such as computer software and, increasingly, 3D models, easier. A functional design guarantees that each modular component of a device serves a single goal and does so with as few side effects on other components as feasible.

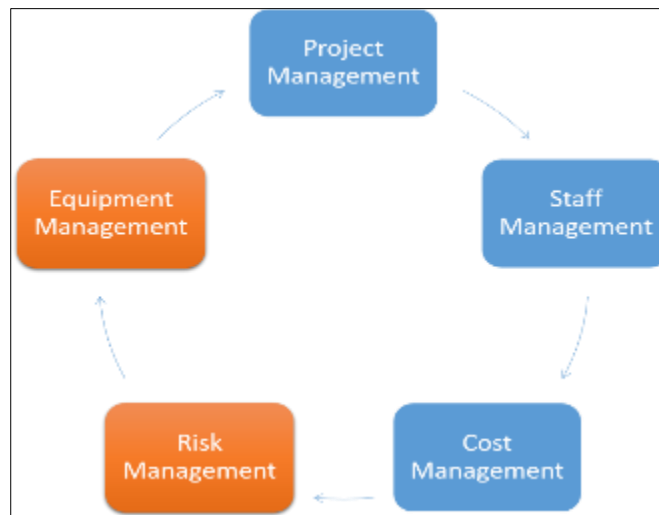


Figure 2 Functional Design of proposed BUSIM

### 3.3. BUSIM User Interface and Usability Development

In the BUSIM app, the user interface (UI) is the point of interaction and communication between the manager and the system. The visual layout of the BUSIM components that a user could interact with on the BUSIM app is well designed for ease of use in line with the objective of the research.

This comprises of:

- The login pages
- The analytics dashboard
- The forms

The BUSIM vital pages which include safety/risk management page, the project overview page, the project detail interface, the equipment management interface, the report dashboard, project tracking overview interface

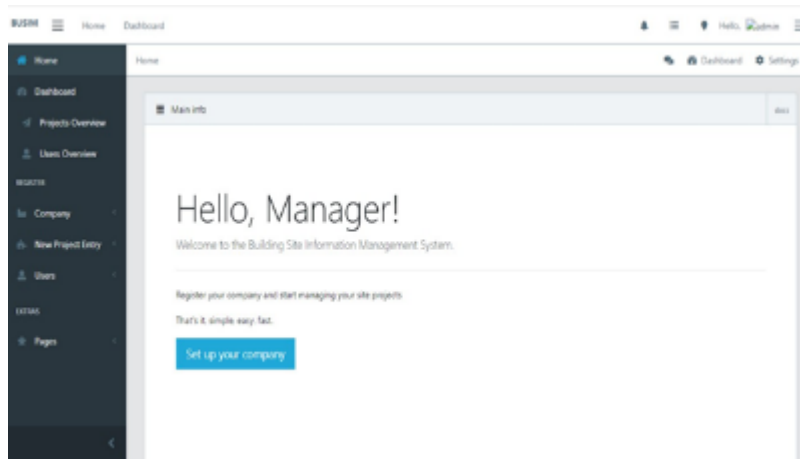


Figure 3 BUSIM Welcome Screen

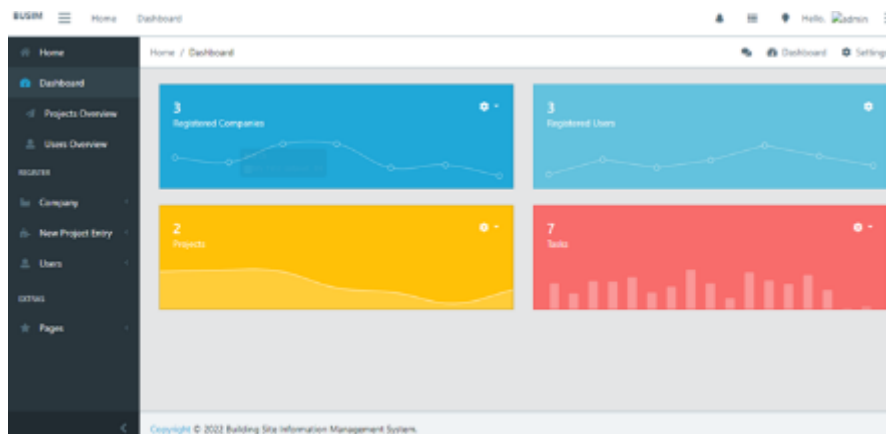


Figure 4 Analytics Dashboard

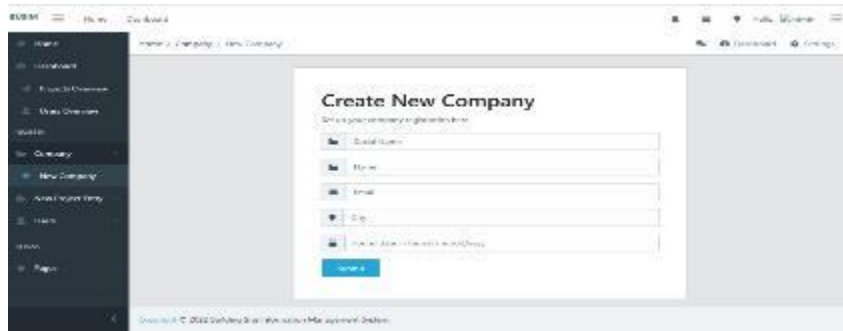


Figure 5 Create Company

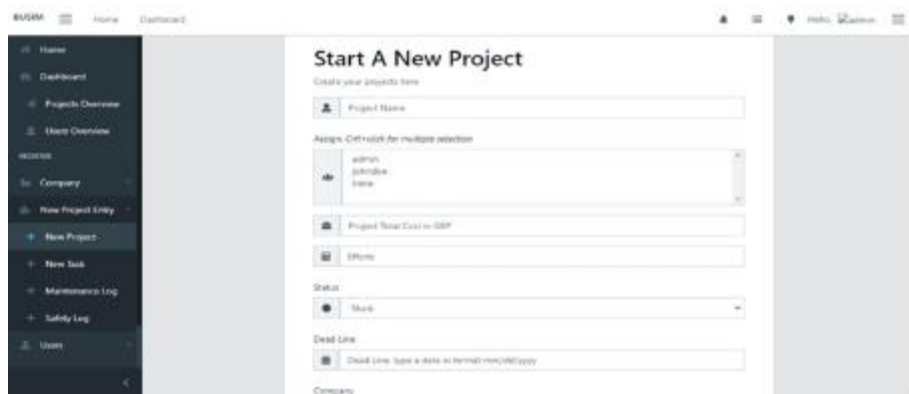


Figure 6 Start a new project

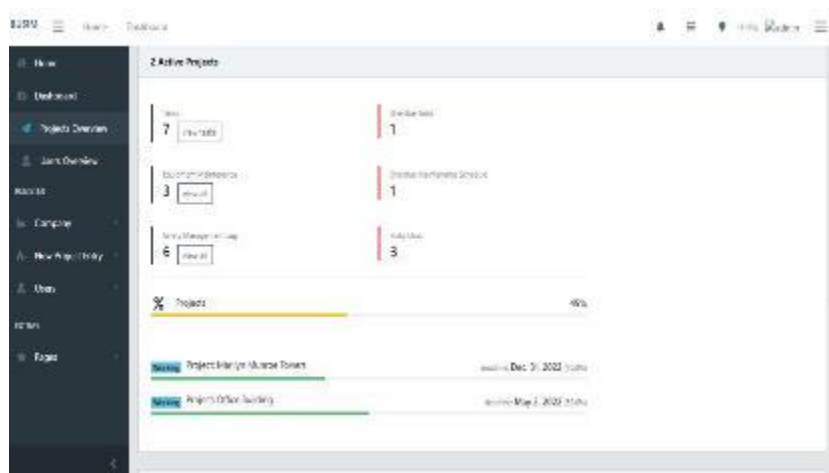


Figure 7 All Project Overview

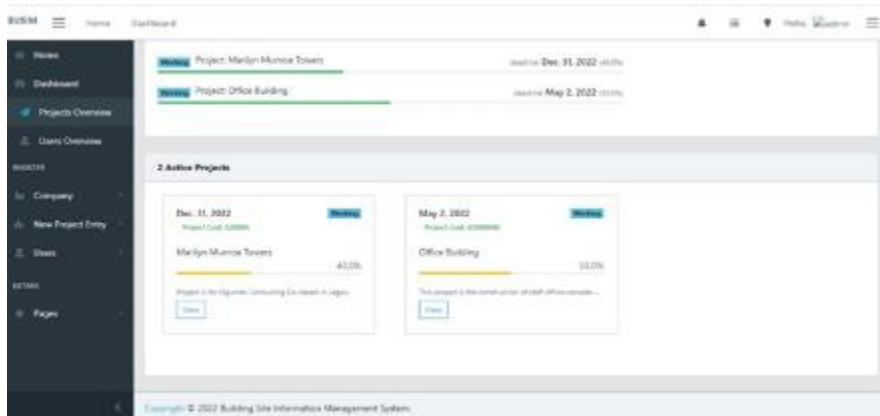


Figure 8 Project Stats

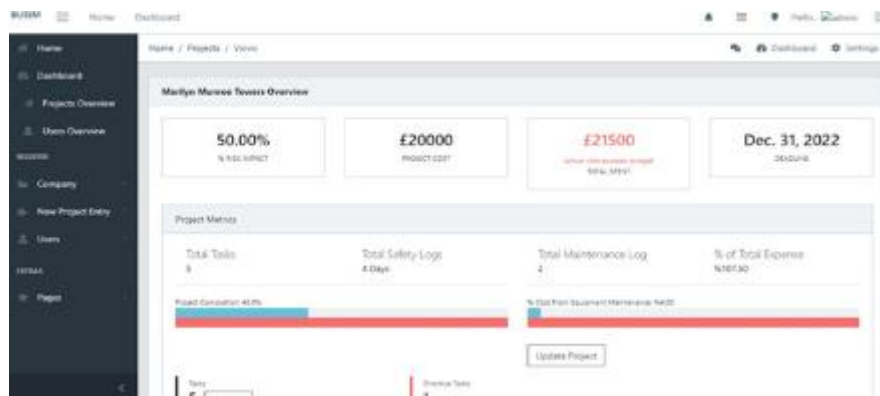


Figure 9 Project Detail Page



Figure 10 Project Detail Page 2

#### 4. Conclusion

Traditional construction site management methods, on the other hand, are struggling to meet the information demands of today's construction business. Despite the fact that BIM technology has revolutionised the design process for many building and infrastructure projects [1], it is rarely used efficiently during the construction site management phase [3]. As a result, a solution is required that would both replace the manual methods presently in use in Nigeria and also serve as a clever intelligent system to enhance the site management process in Nigerian construction projects. Furthermore, present methods seldom consider the human and environmental risks that might Affect project deliverables on a broader scale.

Building site information management (BUSIM) is a prototype of an effective, simple and user friendly cloud based smart tool that can efficiently bridge the gap currently observed in the building construction industry in Nigeria. These gaps include risk impact assessment derived by daily safety management log system which takes into account human and environmental factors, equipment maintenance system that can track when mechanical equipment are due for servicing which when in bad shape can cause time lags and negatively impact project timeline. These features comes with other features already existing in other reviewed systems like cost management, project management, collaboration and open internal stakeholder access.

### *Recommendation*

While the proposed and developed prototype system could demonstrate how gap can be bridged, it does also uncover the possible innovations opportunities that lie within this area of interest.

BUSIM was developed as a prototype with specific focus on lacking features for on-site management when compared with existing building information models and systems. However, effective enterprise level implementation is needed and possibility of use should be adopted by societies in Nigeria as well as clients and stakeholders with companies.

In addition, managing on-site workers to ensure all safety measures are strictly carried out to mitigate human risk side of building projects is lacking and concept only tested in BUSIM. A more robust system architecture and model can be built on this in further researches. This can be standalone on-site workers management system to combat on-site accidents that can hamper project deadlines in severe cases. This can also be integrated in existing systems as an improvement.

The research project focused on 3 site projects in Nigeria but could be extended to the construction industry to cater for engineering and civil constructions projects that use heavy hazardous equipment in working.

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## **Compliance with ethical standards**

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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