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Development of a Construction Cost Estimation System

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ABSTRACT
Construction cost estimation is an important stage in the construction project life cycle. Construction projects need effective and proper cost monitoring and management from the inception of the project. A project is considered successful when it is finished within a limited cost, time, and the required quality. The three items (cost, time and quality) depend on each other; any changes in one of them affect the other positively or negatively. Cost is the principal item affecting everything among the three hence the need for this study. Estimation is a crucial activity to develop cost estimates for a proposed project. The use of a computer to create cost estimate should therefore be practiced due to the importance of cost estimation on a proposed project. This dissertation identifies why construction projects run behind schedule and the characteristics that help projects get finished on time. Bill of quantity estimation is a method that contractors use to estimate costs and this study creates a computerized bill of quantity system for the contractors. To create estimates, contractors frequently use Microsoft Excel but this dissertation produces a cost estimation system using some programming languages like HTML, PHP, CSS and JavaScript and utilizing the Object-oriented analysis and design methodology (OOADM). This system is capable of producing cost estimates automatically. To aid contractors in creating a more accurate and organized cost estimate and to help track the fund's movement, this system acts as a systematic framework composed of construction project components.

Keywords: cost, cost management, construction industry, project manager, cost estimation, time, project

I. INTRODUCTION

The industry is a vital component of Nigeria's economy. The industry includes both public and private sectors, but the private sector is the most dominant. The acquisition of products and services, as well as the implementation of projects, are among their responsibilities (Okoye, 2016). Globally, the industry accounts for 6-9 percent of some countries' Gross Domestic Product (Kanyago et al., 2017).

The construction sector has seen numerous significant changes over the years, the majority of which are the consequence of new technologies used, the aim to achieve organizational objectives (Fashina, 2020), and the use of project management systems in the industry (Demirkesen & Ozorhon, 2017).

When a construction project is completed on time and on budget, it is called a success. These three factors are interdependent: cost, time, and quality (Faten et al., 2020).

Cost estimation is an important stage in cost management for construction projects, according to Hatamleh et al., 2018. Poor scope definition, unrealistic time schedules imposed in contracts, inaccurate activity cost estimates, schedule changes, poor work breakdown structure definition, project manager inexperience, and lack of proper training are all factors that affect cost management (Faten et al., 2020).

In the life cycle of a construction project, cost management is critical since it defines the project's success as well as whether it will be completed on time and under budget (Faten et al., 2020). Construction cost can also be regarded as a major aspect in determining a project's success at the onset, and it is critical to have an accurate construction cost because it will be required to

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complete a construction project effectively (Savas & Saad, 2016).

One of the main obstacles to Nigeria's economic growth is indeed the failure of construction projects. (Adebisi et al.,2018).

The goal of this dissertation is to develop and deploy a computerized construction cost management system that will aid project managers in cost forecasting, job monitoring, cost monitoring, and decision-making.

1.1 STATEMENT OF THE PROBLEM

Funds are the lifeblood of every successful project; the construction sector in Nigeria faces numerous issues, such as:

1. Estimation of project budgets by using analogue methods such as Excel.
2. Difficulties with communication.
3. Difficulty in keeping track of completed projects.

1.2 AIM AND OBJECTIVES OF THE STUDY

This dissertation aims to build and implement a centralized construction cost estimation system for managing the construction's design, cost, quality, schedule, and safety to provide a good finished product. The system will also be able:

1. To create an elaborate cost estimation platform for a construction project.
2. To provide real-time access to information.
3. To coordinate communication among all parties involved in a construction project.
4. To create a database to store completed projects and keep track of them.
5. To generate reports at various stages of a project's lifecycle.

1.3 SIGNIFICANCE OF THE STUDY

The construction cost management system enables construction organizations to keep track of the projects completed and improve communication and transparency with their employees.

In the Nigerian construction industry, the quantity surveyor benefits immensely from this system as it assists in cost assumption, prediction and tracking.

This system assists the people in charge of the construction project (such as the project manager, architect, or quantity surveyor), in processing real-time data, and in keeping track of tasks completed throughout the project.

1.4 SCOPE OF THE STUDY

The dissertation was restricted to the construction of houses in Nigeria. The study sample was primarily made up of quantity surveyors, owing to the dissertation's focus on construction cost estimation.

II. REVIEW OF RELATED WORKS

Anastasios, 2019 defined Construction project management is defined as the process of directing, controlling, and supervising a project from start to finish. A construction manager's principal purpose is to fully satisfy his or her client's budget and quality requirements.

In 2019, Biniyam defined construction project management is the total planning, coordination, and control of a project from start to finish. Understanding the design and construction process is necessary for managing construction projects, in addition to knowledge of modern management.

2.1 CAUSES OF DELAY IN CONSTRUCTION PROJECTS

The circumstance that causes projects to be finished later than anticipated under the terms of the contract is referred to as a construction delay (Isyaku et al., 2020) and this delay is usually detrimental to the stakeholders (Fashina, Fakunle, & Opiti, 2020). The negative effects of construction delays include poor contractor performance, work interruptions, longer construction times, higher construction costs, third-party claims, more frequent contract disputes, decreased productivity, contract termination, and complete project abandonment (Mamman et al., 2019).

According to Mamman and Umesi's research in 2022, the following are some factors that contributed to the causes of delays in construction projects in Nigeria:

1. Delay in payments (Owusu & Aggrey's, 2020; Isyaku et al, 2020).
2. Lack of fund by client (Owusu & Aggrey, 2020; Isyaku et al., 2020).
3. Change in government. (Mamman & Umesi, 2022).
4. poor site management and supervision
5. lack high technological innovation mechanical tools
6. difficulty of contractor in funding project
7. late handling over of site to contractor
8. shortage of equipments
9. government procedure
10. Interference by client leading to award of contract to unqualified contractors.
11. Unclear and insufficient sketches
12. Low level of equipment operator skill. (Mamman & Umesi, 2022).

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In 15 nations, including the United States, Hendrik (2021) conducted 17 separate researches on the causes of delay. He divided the causes of the delays into three categories: contractor delays, owner delays, and external factors, which included situations where neither the customer nor even the contractor was directly responsible for the delay. One common factor in many of the delays, according to the results of the survey, is poor planning and scheduling.

Rashid in 2020 looked into the reasons behind the delays in Pakistani construction projects. Contractor-related variables, consultant-related factors, client-related factors, general-related factors, material-related factors, and labor-related factors were identified as the key reasons.

In India, Sagarkumar (2020) investigated the causes of construction project delays. Excess workload, absence of quality labor management, corruption, equipment shortages, and changes in laws were all highlighted as important contributors to construction project delays in his study.

In a similar study conducted in Morocco, Bajjou and Chafi (2020) identified ten causes of delays in the Moroccan construction industry, including a lack of employee training, delays in advance payment, unrealistic contract time durations imposed by clients, lack waste disposal strategy, corrections due to construction errors, delays in receiving a permit from the relevant agencies, excessive subcontracting, ineffective planning and scheduling, and a lack of skilled labor.

2.2 EMPIRICAL REVIEW

Daegu et al., 2020 proposed using big data technology to schedule data and integrate expenses in construction cost management software, which is a major difficulty in the industry. The suggested cost-schedule data integration algorithm ensures consistency and integrity in construction management data that is complex, dynamic, and large. The proposed algorithm aims to tackle the major difficulty with existing techniques by delivering credible and flexible cost-schedule data and minimizing time spent constructing and updating databases.

Ogunde et al., 2017 investigated the issues that Nigerian construction project management systems face. According to Ogunde et al., successful construction project management requires the development and knowledge of management abilities in planning, organization, coordinating, and controlling. They went on to divide the project management problems in the construction industry into six categories:

- Project Managers: Project managers are involved in the project lifespan in a passive manner.
- Client: The client's participation in the decision-making process is lacking.
- Substandard materials are provided.
- Malfunctions in the design.
- A breakdown in communication between the construction team, the project manager, and the client
- Workforce mistreatment

Cost overruns, delay time overruns, conflicts, abandonment, and other issues would arise as a result of one or more of these challenges.

According to Cindrela and Ananthanarayanan in 2017, there is too much complexity in construction projects that makes estimating project prices challenging. Cost overruns are a significant problem in project management. Scope creep, rework, construction delays, and awarding the contract to the lowest bidder are the most common causes of cost overruns. Other causes include incomplete design; scope and specification changes; design changes; design flaws; design delivery delays; site disputes; price fluctuations; wage and material price increases; poor site teamwork; and poor communication.

According to Kirthiga (2016), the expansion of development-related programming has resulted in the formation of more effective and emotionally supportive networks for the management of both the development organization and its construction sites. Planning, position advancement for executives, purchasing and acquisition, cost management, and hardware board are all examples of site-related activities that can now be accomplished using small PC programming. Organization, building, venture control, plants, and equipment are all areas where PC applications are used in the construction industry. In-house programs, quick programming bundles, and nonexclusive programming are all examples of programming challenges in Kuwait's development business.

Project management software and board programming, according to Vukomanovic (2012), are systems capable of arranging and supervising resource pools as well as producing asset estimations, asset division patterns, and asset accessibility rates. Task programming can also be used as a quality management system, and it has a significant impact on development executives. He also distinguishes between three types of computer application programming used in the creation of

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assets for the executives, such as MS Project, Primavera, and others. According to his research, the first type has limited PM capacities and relies primarily on booking strategies; the second type is an unpredictable task portfolio, the executive's framework that attempts to combine all PM cycles with Big Business Asset Arranging (ERP); and the third type is an unpredictable task portfolio, the executive's framework that attempts to combine all PM cycles with Big Business Asset Arranging (ERP).

III. RESEARCH METHODOLOGY

Object-oriented analysis and design methodology (OOADM) was used to construct the system in this research report. This is due to the fact that OOADM is a widely established software engineering model that is commonly employed in most object-oriented analyses.

IV. MATH SPECIFICATION

The term "cost modelling" is commonly used to describe the process of cost estimation. Whether it's based on functional, performance-related, or elemental cost analysis, or specific rates computed by contractors when estimating bids, any type of cost prediction can be regarded as a cost model.

The Quantity Surveyor's estimate is based on a Bill of Quantity, which consists of a list of items and the associated quantities from which the total construction cost is derived.

This project's estimate is calculated using the quantity, unit price, and total cost, as well as the following equation:

Estimate = $\sum_{i=0}^{n}(q * p)$

Where q denotes the quantity of material required,
p denotes the material's unit price,
and n is the number of materials required.

Example 1: Estimate based on quantity surveyor's list of quantities

Here's an example of how the contractor's total estimate for a fence project is calculated. Table 1 displays the itemized expenses for various job elements, as well as the total estimate.

TABLE 1: Contractor's Total Estimate for a Fence Project

Items	Unit	Quantity	Unit price	Item cost
Excavation of Trenches	M	104	600	62,400
Excavation of Column Bases				
1.50 x 1.50	Nr	2	1500	3,000
Blinding, Foundation Footing, Coping & Piers				
Cement	Bags	90	0.50	603,750
Sharp Sand(10tyres tipper)	Trips	1	2.00	1,050
Granite (20 tons tipper)	Trips	1	3.00	21,000
Labor for Casting				90,000
Blocks				
Cement	Bags	60		
Sharp Sand (10 tyres tipper)	Trips	3		
9" Block	Nr	3,010		
Labor	Nr	3010	60	180,600
Reinforcement				
12mm Diameter High Yield Bar	Length	7		
10mm Ditto	Length	4		
Iron Benders				10,000
Formwork				
1"x12"x12" Planks	Nr	50		
2"x3"x12' Planks	Nr	20		

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TABLE 1: Contractor's Total Estimate for a Fence Project

Items	Unit	Quantity	Unit price	Item cost
Carpenters				15,000
Plastering				
Cement	Bags	80		
Plaster Sand (10 tyres tipper)	Trips	5		
Labor				350,000
Painting				
Labor				200,000
Metal Works				
Vehicular Gate	Nr	1		
Fence Metal Grilles	Nr	6		
Concertina Barbed Wire	M	108		
Electrical Works				
Piping and Piping Fittings				
20mm Diameter PVC Pipe	Bundle	1		
20mm Coupler	Pkt	1		
Cables and Wiring				
1.5mmsq Single Core PVC Cable	Coil	2		
Lightings Fittings				
1x 40W Bulkhead Lighting Fittings	Nr	16		
Labor				
Builders Works in Connection with Piping				40,000
Ditto Wiring				35,000
Ditto Fittings				35,000
Total	**₦1,021,000.00**			

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V. SYSTEM FLOWCHART

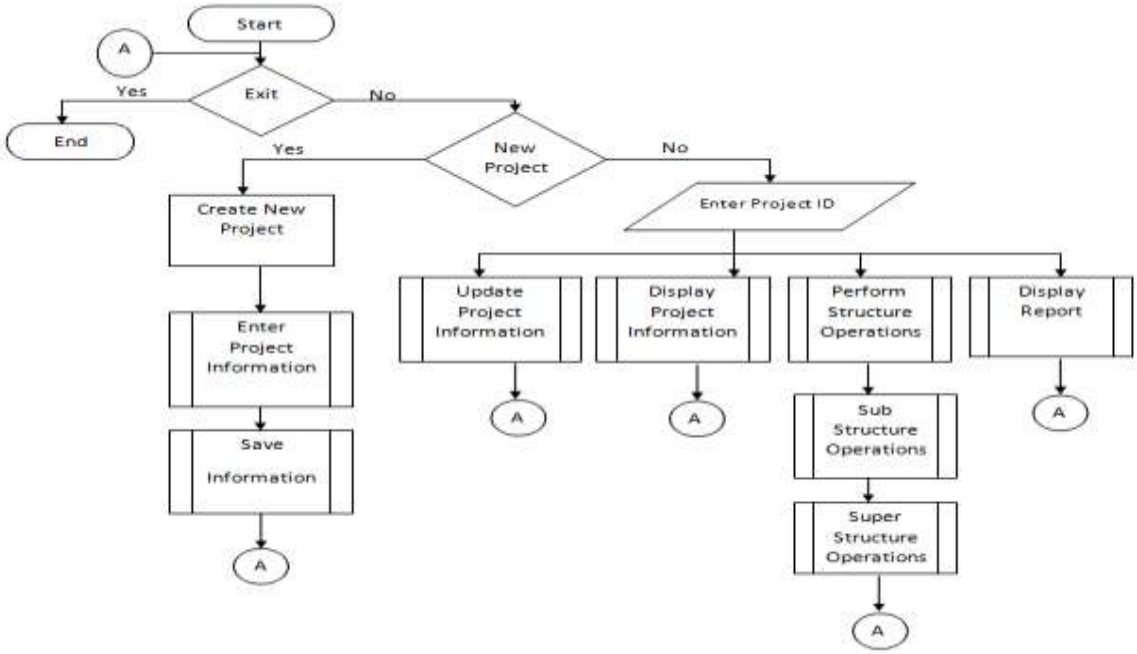

Fig 1: System Flowchart

6. Program Module Specification

A top-down approach was used to create the program. It employs basic program-solving methods. Each subsystem is chosen and operated individually in the software. The task is broken down into multiple modules, which are then combined to provide a solution to the problem. Following are the tasks:

a) The Login Form Module

The form serves as a means for users to authenticate themselves and gain access to the new system.

b) The Estimation Form Module

This enables the project manager to forecast the project's cost and whether the client will indeed be able to complete the work. The project manager fills in the projected material, labor, and equipment requirements and receives a final estimate.

c) The Project Form Module

A new project can be registered in the project form module by entering the project name, kind of building, start and end dates, project manager(s) and team member(s) allocated, project estimate, and thorough description of the project.

This module also gives a way to see which past projects are available.

d) The View Project Form Module

In this module, past and present projects details are displayed. Here all the details of the project are displayed.

e) The Edit Project Module

This module permits for modification to be made to desired projects.

f) The Task Form Module

After the team member or manager has gone over the project in detail, they can update it with the tasks that have been performed and what still needs to be done. The task form module then displays the various tasks that have been completed by members of a project's team, as well as those that have been assigned by the manager.

g) The User Form Module

In the User form module, new employees are registered with their first and last name, email address, and password for login details, avatar, and role in the team.

This module also allows you to examine and change old employee records.

h) The View User Form Module

In the view User Form module, details of users are displayed in this form.

i) The Report Form Module

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The project summary can be printed using the report form module.

VI. INPUT / OUTPUT FORMAT

7.1 INPUT FORMAT

The input/output design for the model of construction cost management system is as follows:

Fig 2: Estimation Page

7.2 OUTPUT FORMAT

The system designed allows administrators and users to retrieve information from the database. The system is real-time and the design is dynamic. Below are some of the output specifications and design.

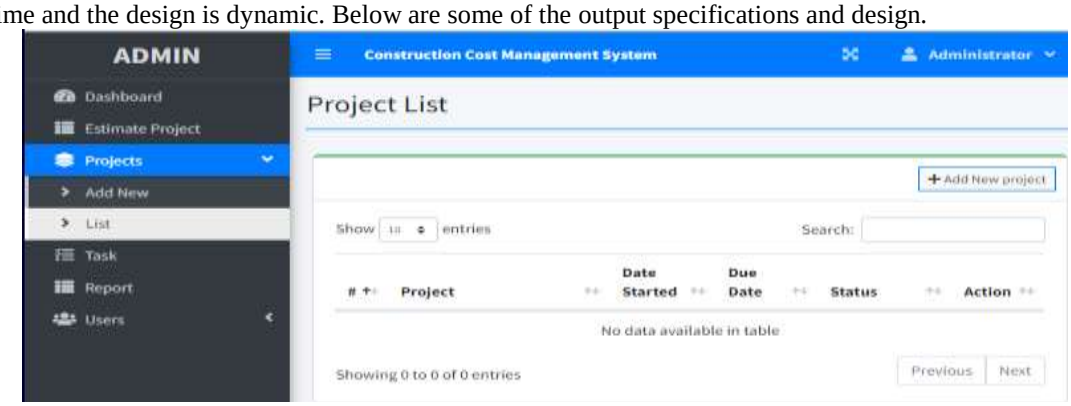

Fig 3: View Project Page

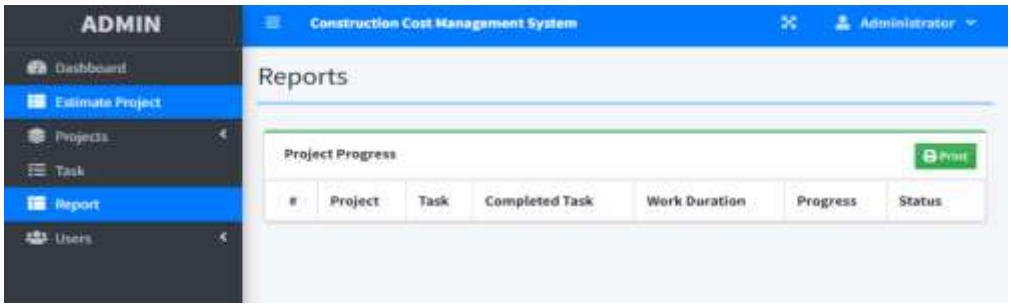

Fig 4: Report Page

Fig 5: View User Page

VII. ALGORITHM

An algorithm is the step-by-step processes or procedures that make up a program. The new system's algorithm is as follows:

Start 1: Start

Start 2: Login to construction cost management system

Start 3: Visit homepage if login was successful else remain at **Step 2**

Start 4: If Login equals Admin, Select a module (Estimates, Add/List Project, Tasks, Add/List User, Report) by clicking on it.

If Login = Staff, select a module (List Project, Tasks, Report).

Start 5: If you selected estimates fill in all data capture fields and click submit; if you clicked submit, the database will be filled with data.

Start 6: If an Add/List project is selected, fill in all data capture fields and save, then search for projects to update the project if necessary.

Start 7: View the tasks linked with a project if the task is selected.

Start 8: If an Add/List user is selected, fill in all data capture fields and save, then search for users to update their record if necessary.

Start 9: Print the project summary if the report module is selected.

Start 10: Logout when you've finished your work on the system.

Start 11: End if

VIII. CONCLUSION

A construction cost management system that aids in estimating a project's overall cost was designed and developed as part of this research project. When funds are limited for construction projects, it decides where to start and stop and helps to regulate the movement of credit funds into and out of the project. It achieves this by breaking the construction process down into twelve (12) phases, with estimates being made for each stage. After obtaining accurate data, a database layer was built by choosing and assessing influencing factors. Based on this database, a building cost management system was created, and via verification, we were able to get an excellent outcome.

IX. RECOMMENDATION

To better manage projects, the future Construction Cost Management System should be able to include a more precise job scheduling system and a cost monitoring module. The Construction Cost Management System should also be able to integrate the building's architectural designs.

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