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Web-Based Automation for Accurate Cost Estimation and Quotation

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Abstract: Quantity Surveying (QS) plays a critical role in overseeing and managing construction project costs. However, conventional QS practices—often dependent on paper-based documentation and Excel spreadsheets—can be inefficient and prone to estimation inaccuracies. This study introduces a web-based QS automation framework developed using ASP.NET, designed to improve the efficiency and accuracy of cost estimation for concrete structures. The system provides a user-friendly interface that aligns with the logical sequence of construction activities, thereby improving usability and workflow. Expert validation using real project data demonstrated the framework's effectiveness, showing a notable improvement in accuracy and speed. The automated approach achieved a 99% accuracy rate in cost estimation, significantly reducing the computation time from 114 days (manual) and 19 days (Excel) to just 3 days. These improvements highlight substantial savings in both labor and time, offering a reliable and scalable solution to modern QS challenges.

Keywords: Quantity Surveying; Automation Framework; Concrete Construction; Web-Based System; ASP.NET; Cost Estimation; Project Management.

I. INTRODUCTION

Building Information Modeling (BIM) has garnered widespread attention for its ability to optimize construction workflows by enabling automated quantity take-offs and cost estimation through digital modeling. Quantity Surveying (QS), which centers on managing and monitoring construction expenses, has historically depended on manual or semi-automated methods that are often inefficient and prone to inaccuracies. Quantity Surveyors (QSr) play a vital role in managing the financial and contractual dimensions of construction projects. However, traditional QS methods involve cumbersome paperwork and outdated, non-intuitive systems.

Small and medium-sized enterprises (SMEs) frequently face barriers to adopting advanced QS tools due to the high cost of commercial software and required infrastructure. This highlights the urgent need for affordable, automated systems that support accurate cost estimation and quantity extraction. The use of modern information technologies—such as computer-aided and web-based solutions—can significantly enhance productivity, streamline communication among stakeholders, and improve overall cost control. Despite these benefits, the adoption of such technologies is often hindered by factors like high implementation costs, complex development processes, and limited infrastructure.

The standardization of the Bill of Quantities (BoQ) is another critical component, as it improves the accuracy and consistency of cost estimates by aligning construction items with associated material and labor costs. Contemporary estimation software often includes dynamic resource cost databases, allowing regular updates and leading to more precise forecasting and budgeting.

Estimating and costing are foundational to construction project management, directly impacting project feasibility, financial planning, and profitability. Microsoft Excel continues to be a widely used tool for these functions, offering a flexible platform for data organization, cost tracking, and analysis. Its intuitive interface and robust calculation capabilities support the creation of detailed estimates and informed decision-making. However, the role of Excel in construction cost estimation remains underexplored in the literature.

This paper seeks to address this gap by evaluating the strengths and limitations of Excel in construction project costing and identifying strategies to maximize its effectiveness. Furthermore, quotations are instrumental in financial planning,

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serving as formal cost proposals and outlining transaction terms for goods and services. These documents foster transparency and support effective communication and negotiation between parties, particularly in the construction industry. They detail pricing, taxes, product specifications, warranties, and other contractual terms—serving as the foundation for commercial agreements.

By integrating digital tools such as Excel with standardized QS practices, construction professionals can significantly enhance the precision of cost estimation, streamline financial procedures, and improve the overall efficiency of project management.

II. RELATED WORK

A web-based quantity surveying (QS) framework built using ASP.NET automates the estimation of concrete costs, replacing traditional manual approaches and Excel-based methods. By incorporating Google Maps for enhanced location accuracy, the system reduces project timelines from 114 days to just 3, while maintaining high levels of reliability, efficiency, and cost-effectiveness [1].

This research investigates the use of Microsoft Excel in estimating construction costs. Although Excel's flexibility and user-friendly interface support effective data management, the reliance on manual input and intricate formulas often results in errors. The study advises adopting dedicated software, automating data integration, implementing quality control measures, and offering proper training to improve both precision and efficiency [2].

The study presents a web-based Quotation Management System (QMS) designed to streamline the process of creating, organizing, and monitoring quotations. The system enables efficient handling of client records, status tracking, and report generation, thereby improving security, scalability, and overall operational efficiency [3].

An automated mobile application has been developed to simplify the estimation of material quantities and costs for both substructure and superstructure components. The app is user-friendly and tailored for individuals without formal civil engineering backgrounds [4].

A study utilized neural networks developed in MATLAB to achieve fast and accurate cost estimation for construction projects. Using data from 10 educational buildings in India, the system produced reliable cost predictions and significantly improved estimation efficiency [5].

Another study examined the integration of quantity surveying (QS) data and Building Information Modeling (BIM) to automate mechanical and electrical (M&E) construction planning. It proposed a data warehousing framework to enhance decision-making and optimize scheduling for installations [6].

A comparative analysis between conventional and online cost estimation methods for residential buildings revealed that incorporating IT solutions leads to higher accuracy, time savings, and fewer errors [7].

A smart web application was introduced to automate the calculation of material quantities and costs directly from AutoCAD drawings. This tool minimizes human error and delivers real-time cost data for reporting and tendering purposes [8].

A support vector machine (SVM) was employed to optimize the regression problem in construction cost estimation The SVM model used building and structural component features related to the floor structural frame, with outputs representing the corresponding actual cost estimates. The experimental results demonstrated that the model can predict costs with satisfactory accuracy [9]..

A survey conducted on the use of artificial neural networks (ANNs) explored their effectiveness in estimating the total cost of stadium construction. The study suggested that MLP-type networks could be generally applicable in mapping the relationship between total construction costs and specific cost predictors related to stadium characteristics [10].

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III. PROPOSED METHODOLOGY

This research focuses on the creation and implementation of a web-based Quantity Surveying (QS) framework designed to automate cost estimation for concrete construction projects. Utilizing the waterfall methodology, the development follows a structured, sequential process. The framework is informed by a comprehensive literature review, which identified existing limitations in traditional QS practices and the underutilization of Building Information Modeling (BIM) capabilities.

Through the analysis of prior studies, the research emphasizes the inefficiencies of manual QS methods and underscores the advantages of incorporating automation into construction cost estimation. In particular, the study addresses the time-intensive nature of conventional processes and the need for greater accuracy and efficiency.

To assess the effectiveness of the proposed system, a qualitative research approach was adopted. Data was collected through interviews with industry experts and engineers, whose practical insights were instrumental in validating the system's design and ensuring alignment with professional standards. The framework prioritizes user experience, offering an intuitive interface that simplifies complex cost estimation tasks and enhances usability.

The system automates the entire cost estimation workflow, significantly reducing the potential for human error while improving resource management. An interactive relationship overview diagram accompanies the framework, mapping out the flow of data and interaction among various system components—including data input, computation, and output. This visual representation clarifies how the system operates in real-time and demonstrates its ability to streamline QS processes.

By integrating BIM functionalities with QS activities, the framework facilitates enhanced collaboration among stakeholders, contributing to better project planning and execution. Its efficient data processing capabilities enable quick, accurate cost assessments, making it a valuable asset for construction professionals seeking to modernize their cost management practices.

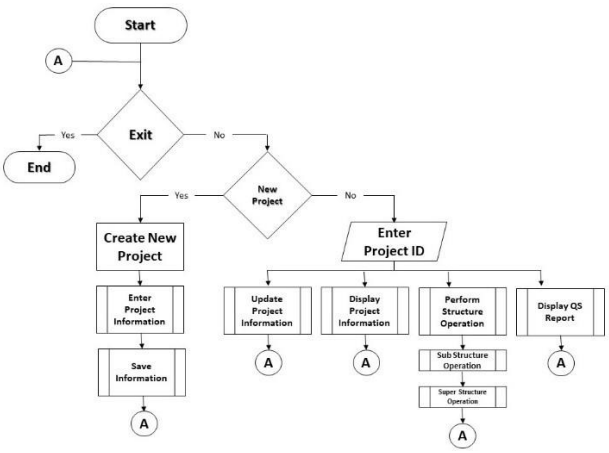

Figure 1. Proposed System (Block Diagram)

The developed web-based framework leverages the Visual .NET platform, utilizing ASP.NET and C# to streamline and automate Quantity Surveying (QS) tasks. Designed to enhance efficiency, it incorporates over 200 calculation equations and features an intuitive interface with more than 50 structured web pages. These pages guide users through each phase of QS operations, starting from project registration to the final report generation. Upon logging in, authorized users can either create a new project or modify an existing one. The project registration form captures key details, such as project title, owner, budget, start and end dates, ensuring that all essential data is securely stored in the "Project information" database table. This structured database enables smooth project management by allowing users to create, update, retrieve, and delete information as needed.

Once a project is registered, users can initiate cost estimation and other QS-related computations. Users can input data manually through a “detail view” control or opt for an automated file upload feature, which allows consultants to import pre-prepared data, significantly reducing entry time and minimizing errors. The framework executes SQL scripts in the background to process and store data seamlessly. The outcomes of calculations and operations are instantly displayed

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using a "grid view control," providing users with real-time insights into cost estimation and QS metrics. By combining automation with an intuitive interface, this framework significantly improves the accuracy, speed, and overall efficiency of QS processes, making it a valuable tool for construction professionals.

Software Functionalities Requirements:

The proposed system is designed to perform comprehensive resource calculations for construction projects, particularly focusing on both the sub- structure and super-structure of buildings. It calculates the required materials such as concrete, cement, blocks, and steel based on the structural elements like footing, columns, beams, slabs, and floors. The system is equipped with a database that facilitates CRUD operations—Create, Read, Update, and Delete— ensuring seamless management of project information. All the calculation equations integrated into the system were thoroughly validated by industry experts and consultants, guaranteeing that the calculations follow the standard formats and construction practices.

Non-Functional Requirements:

i. Enhanced QS Services: The system aims to significantly improve the efficiency of Quantity Surveying (QS) activities by automating complex calculations and reducing manual involvement.
ii. Accessibility: The platform is designed to be fully web-based, allowing users to access it from any location, at any time, ensuring that project management and QS tasks are not restricted by physical boundaries.
iii. Performance: The system should deliver high performance, enabling rapid calculations and smooth user interactions, even for large-scale projects.
iv. Scalability: It is built to support the addition of new products and services, adapting to the changing needs of construction projects and industry requirements.
v. Improved Control: The system enhances control over the project data, allowing authorized users to manage information securely, reducing the risk of data breaches or inaccuracies.
vi. Error Reduction: By automating calculations and data entry, the system minimizes human errors, reduces the time and effort required for manual processes, and cuts overall costs associated with QS activities.

Functional Requirements:

i. Project Information Storage: The system stores essential details of the project, such as the project name, owner, budget, and timeline. This information serves as the foundation for accurate cost estimation and resource allocation.
ii. Concrete Calculations: It calculates the amount of concrete required for various construction elements, including the Plain Cement Concrete (PCC) for foundations, footing, columns, plinth beams, and the beams and slabs of the ground floor, first floor, second floor, and penthouse.
iii. Cement Calculations: The system calculates the amount of cement required for different works, including blocks work, column construction (assuming site-mixed concrete), plaster work on walls, and tiling work (both walls and floors). It also calculates the total number of cement bags needed for the entire project.
iv. Block Calculations: It calculates the number of hollow blocks (40 × 20 cm) needed for wall construction, along with the full/solid blocks required for foundation walls.
v. Steel Calculations: The system estimates the steel requirements for various structural elements, including the foundation (footing, base columns, plinth beams), ground floor (columns, beams, and slabs), first floor (columns, beams, and slabs), and penthouse floor (columns, beams, and slabs). The total steel required for the entire project is also calculated.

By automating these resource estimations, the system ensures that project planners and quantity surveyors can accurately calculate material needs, optimize costs, and avoid errors that often arise from manual calculations. The framework enhances the overall efficiency and accuracy of the QS process, contributing to better project management and cost control.

Dataset:

A critical literature review was conducted to identify implementation gaps and assess the impact of BIM and QS features. Additionally, expert interviews were performed to validate theoretical computations. The phase interactions of the proposed framework are illustrated in Figure 2.

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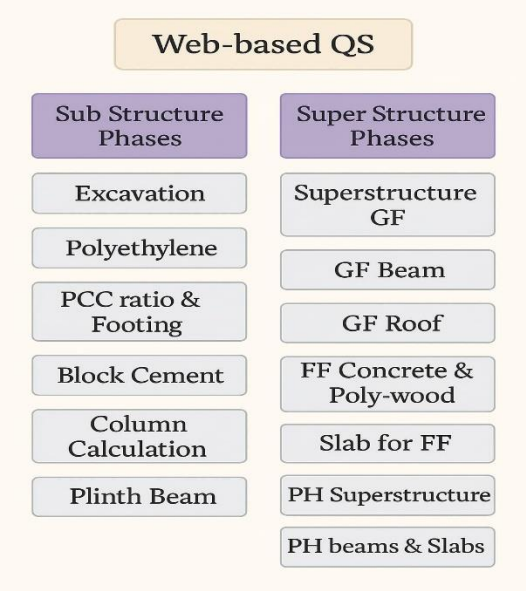

Figure 2. Phases of Sub and Super-Structure.

Figure 2 illustrates a Web-based Quantity Surveying (QS) framework that organizes construction phases into Sub Structure and Super Structure processes.

Sub Structure Phases:
These steps focus on the foundation and groundwork:

1. Excavation – Digging for foundation preparation.
2. Polyethylene – Applying protective polyethylene layers.
3. PCC Ratio & Footing – Calculating and applying Plain Cement Concrete (PCC) for footing.
4. Poly-wood Footing – Installing poly-wood material in footing.
5. Block Cement – Laying cement blocks for foundation support.
6. Column Calculation – Computing column dimensions and materials.
7. Plinth Beam – Constructing the plinth beam for structural stability.

Super Structure Phases:
These steps cover above-ground construction:

1. Superstructure GF (Ground Floor) – Initial superstructure construction.
2. GF Beam – Installing ground floor beams.
3. GF Roof – Constructing the roof for the ground floor.
4. Superstructure FF (First Floor) – Continuing superstructure work for the first floor.
5. FF Concrete & Poly-wood – Applying concrete and poly-wood materials for the first floor.
6. Slab for FF – Installing slabs for the first floor.
7. PH Superstructure – Building the penthouse superstructure.
8. PH Beams & Slabs – Completing penthouse beams and slabs.

The Web-based QS system streamlines these processes by providing structured cost estimation and project management, ensuring efficiency and accuracy.

IV. RESULTS AND DISCUSSION

Quantity Surveyors are responsible for managing the financial and contractual components of construction projects. However, conventional QS practices are often labor-intensive and susceptible to errors. To address these challenges, a proposed web-based QS framework was evaluated through a comprehensive literature review and expert feedback. The results demonstrated a significant reduction in processing time—from 163,800 minutes using manual methods and 27,300 minutes with Excel, down to just 3,900 minutes with the new system. This fully automated solution enhances speed, accuracy, and data security, while also minimizing human error and providing the convenience of remote access through a web interface.

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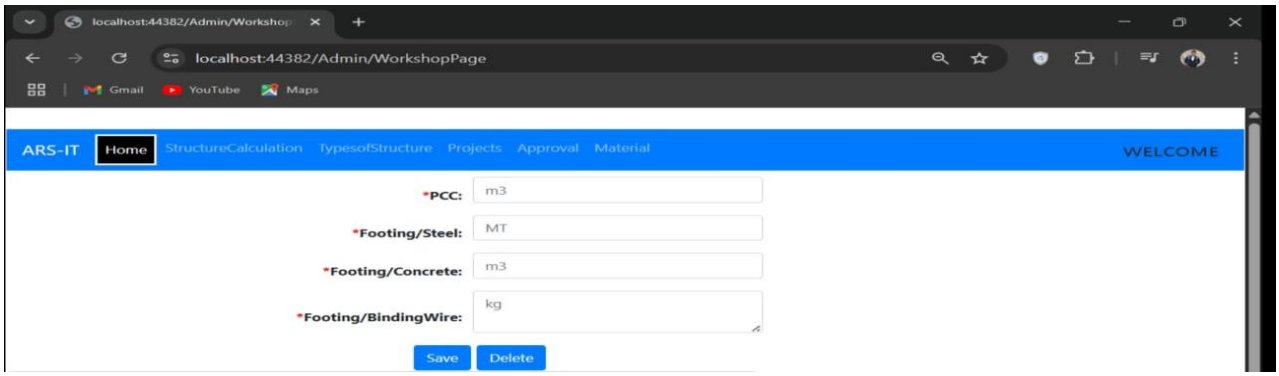

Figure 3. UI INTERFACE OF CALCULATION PAGE

Estimation and Costing Calculations

Calc & Update	Volume(m3)	Price	Cost
PCC	28.3351	4,452	126,147.86
Footing/steel	11.275964	56,763	640,057.54
Footing/concrete	152.902	4,452	680,719.7
Footing/binding Wire	11.275964	7,791	87,851.035

Cost (Rs)	Price per Unit (Rs)	Quantity (m^3)	Description
126,147.86	4,452	28.3351	Concrete before footing thickness of 10cm (PCC)
640,057.54	56,763	11.275964	Reinforcement footing
680,719.7	4,452	152.902	Concrete footing
87,851.035	7,791	11.275964	Binding wires for steel footing and base column
Total	1534776.135/-		

Figure 4. RESULT OF QS CALCULATION.

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Figure 5. UI INTERFACE OF PROJECT

V. CONCLUSION AND FUTURE SCOPE

The proposed web-based Quantity Surveying (QS) framework is designed to automate essential QS functions, delivering accurate and efficient cost estimation specifically for concrete construction projects. Developed using ASP.NET and C#, the system enables project managers to swiftly calculate costs, generate reports in various formats, and track project progress in real-time. A robust database management system supports secure data storage and automatic project data imports, significantly reducing the risk of errors linked to manual data entry.

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The framework's cost estimation accuracy has been verified through comparison with traditional methods and actual project data, confirming its reliability and practical value.

While the system demonstrates strong performance, there is potential for further enhancement. Future development should include expanding the range of QS activities it supports—such as finishing work, plumbing, and labor cost estimations—and enabling integration with advanced estimating tools and Bill of Quantities (BoQ) systems.

Upcoming improvements will also focus on adding file import/export functionalities and deploying the system on cloud or mobile platforms, thereby increasing accessibility and flexibility for users across various project environments.

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