

A Comparative Study of Manual Approach and Centralized Digital Database

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ABSTRACT

The construction industry is progressing toward Construction 4.0; however, project-level information management practices remain predominantly reliant on informal communication tools such as messaging applications and email. This misalignment between technological advancement and operational practice results in fragmented information flows, limited traceability, data silos, and reduced coordination efficiency. This study critically evaluates the limitations of decentralized, manual communication approaches and proposes a centralized, cloud-based information management system tailored for the delivery of built environment projects. A comparative analytical approach was adopted, guided by the System Development Life Cycle (SDLC), encompassing feasibility assessment, requirements analysis, system design, development modelling, and implementation planning. The evaluation focused on key governance and performance criteria, including



accessibility, interoperability, auditability, real-time visibility, and decision-support capability. The findings indicate that manual communication methods contribute to record duplication, delayed information retrieval, constrained managerial oversight, and weakened stakeholder coordination. In contrast, a centralized cloud-based system enhances structured documentation control, integrates project data streams, and provides real-time visibility into work progress, thereby strengthening information governance and enabling evidence-based decision-making. This study contributes to built environment scholarship by positioning project-level information governance as a foundational enabler of Construction 4.0 readiness and by offering a structured framework to support the digital transition in construction project management.

Keywords: Information Management, Workflow Automation, Cloud-based, Centralized Platform, Quantity Surveying Practice, Construction Digital, Built Environment

INTRODUCTION

The construction industry is a key sector across many countries, yet it remains one of the least digitized industries, heavily reliant on a manual approach to information management (Barbosa et al., 2017). Effective communication and structured information management between stakeholders are of utmost importance to ensure the construction project is successfully delivered. In a construction project, quantity surveyors play a crucial role as coordinators, managing variation orders and interim claims whenever changes occur (Chandramohan, Perera, & Dewagoda, 2022). However, most information exchange between quantity surveyors and other stakeholders still relies on manual tools, such as email or WhatsApp. This then causes project information to be scattered across all these platforms, leading to inefficient change tracking, difficulty retrieving past information or records, and fragmented project information.

As the construction industry is getting more complex and the forms of information in a project have increased, such as the introduction of Building Information Modelling (BIM) files, which is the current trend of the construction industry, the limitations of the manual approach of information management are getting more apparent (Waqar et al., 2023). The proliferation of information formats further exacerbates the fragmentation of information across platforms. Quantity surveyors are now facing greater difficulty coordinating among all project stakeholders, as they need to ensure updated information is consistently communicated. Compared to the manual approach, deploying digital solutions enables greater control and management of the vast amount of data in a construction project (Pan & Zhang, 2021). In contrast, a digital solution can provide real-time visibility into progress, accelerating decision-making by delivering information to stakeholders faster than the manual approach.

In the study, digital solutions refer to centralized, cloud-based information management tools, such as Monday.com. The cloud-based information management tool provides a centralized database for stakeholders to upload the latest project information, such as changes, to it. The current manual approach, which involves sending project information through channels such as WhatsApp, might achieve the same goal: information exchange. However, the risk of data loss is higher than when uploading to the centralized database. This integration of cloud-based information management tools marks another step toward digitalization (Construction 4.0) for the construction industry and potentially another increment in project efficiency, as project resources such as time can be reduced.

PROBLEM STATEMENT

Modern construction projects have grown more complex and integrated multiple technologies, requiring consultants to manage the increasing volume of information within a project. In many consultancy environments, critical updates, drawings, site instructions, approvals, and task-related communications are exchanged through

fragmented platforms such as WhatsApp, email threads, PDFs and cloud folders. This fragmented workflow leads to difficulties in tracking information, verifying instructions, and prioritizing tasks effectively.

The absence of a centralized platform significantly reduces operational efficiency in a construction consultant firm. Ineffective communication between the project parties causes construction practitioners to spend excessive time searching for the latest updates or clarifying repeated instructions. According to Quickbase's research report, more than 50% of 1032 respondents across industries in the United States have spent over 10 hours per week chasing the information they need from various people and systems. Such information inefficiencies not only delay decision-making but also increase the risk of errors, such as outdated drawing usage, duplicated work, or the wrong standard material applied in construction projects. One scenario that can illustrate the severity of this issue is when variation orders are issued in the WhatsApp Group. If the quantity surveyors missed one of the variation orders amidst a large volume of site photos and unrelated updates, the variation order will not be properly recorded in the cost plan. This may lead to a dispute when the contractor submits a claim for a variation order, and the client argues that the claim is invalid because there is no official record of the variation order. Previous research also highlights that the fragmentation of information issues in the construction industry hinders the integration of construction knowledge and leads to scheduling problems, delays and disputes during the construction process (Mohd Nasrun Mohd Nawi et al., 2014).

Therefore, a centralized information management system for the organization's construction consultants is essential for integrating all project-related updates, documentation, and task assignments into a single digital platform. By streamlining communication and providing real-time, structured information, the system may enhance efficiency and improve decision accuracy.

REVIEW OF THE CURRENT APPROACH

The conventional approach, before implementing any technologies, is traditional, manual, and fragmented for managing interim valuations, variation orders, and other project instructions. This fragmentation arises from non-centralized communication among project stakeholders, with information scattered across disparate channels such as email and communication platforms. For example, project instructions are typically issued via email or WhatsApp, and quantity surveyors then manually record them into standalone spreadsheets.

This lack of a unified system introduces several inefficiencies. Managing the discrete tasks individually not only inflates the administrative workload but also increases the probability of human errors, such as missed follow-ups and inconsistent project records. These inefficiencies are magnified when the construction project is large, involving hundreds of individuals from material manufacturers to related specialists, such as specialists for bin centres in a condominium (Lu, Li, Skibniewski, Wu, Wang, & Le, 2015). This makes the coordinating role of the quantity surveyor on a project much more complex and time-consuming. Furthermore, a construction project can take several years to complete, and this long duration further complicates information retrieval, as messaging applications like WhatsApp show limited capability for long-term information storage and management.

Overall, the current manual approach is characterized by non-centralized data management and lacks real-time visibility, which directly affect project performance in terms of time, as there were delays in decision-making. These characteristics also make contract administration by quantity surveyors more difficult, and hence the potential for dispute increases.

TECHNOLOGICAL SOLUTION AND AVAILABLE TOOLS

To address the limitations of the current manual approach, many digital platforms are available in the industry. These platforms offer varying levels of integration and functionality, and organizations can choose the one that

best suits their operations. The suitability here is affected by the project's size, complexity, number of parties involved, and organizational direction.

Table 1: Comparative Analysis of Tools

Technology	Strengths	Weaknesses
Manual Approach (Excel, WhatsApp, etc)	Widely used in the industry, therefore, high familiarity with the approach, low-cost	Heavily dependent on manual work, prone to human error, and a lack of live visibility of the work progress
Centralized Information Management Tool (Monday.com)	Automation of manual work, increased data accuracy, and live visibility of the work progress	Subscription cost requires time and effort for user training
Cloud Storage Tools (Google Drive, Outlook)	Risk of file corruption is lower than the manual approach, lower cost when compared to a centralized information management tool, and easy file sharing between stakeholders	Information is stored but still requires manual management, lacks visibility into work progress, and can be messy if not carefully organized.

Table 1 presents a comparative analysis of tools used in information management for construction, highlighting their respective strengths and limitations. While the manual approach is low-cost and most stakeholders in current construction environments are very familiar with it, it is time-consuming because it relies heavily on manual labour. For example, for a construction project with a high volume of variation orders (e.g., over 300 V.Os), it requires substantial time for the quantity surveyors to record and organize them fully. The time spent on recording and organizing indicates that project resources may be inefficiently allocated, and this time could be used for higher-priority work, such as taking off and contract documentation.

Cloud storage tools represent a semi-digitalized approach, enabling easy file sharing between stakeholders and making it easier to trace historical records compared to the manual approach (Yang, Xiong, & Ren, 2020). However, cloud storage tools are still dependent on user discipline, which can lead to inconsistencies because everyone organizes information differently. Cloud data storage also faces data security risks, as construction projects often involve confidential information (Prajapati & Shah, 2022). Cloud storage lacks a critical feature that is also absent in conventional approach, which is real-time progress tracking. The centralized information management tool excels in this area, offering dashboards that provide real-time updates on the project status. This transparency allows the stakeholders to make more informed decisions by reducing the uncertainty surrounding project timelines and financial status.

Speaking of live visibility of work progress, among all these approaches, centralized information management offers the highest level of live visibility. The live visibility of work progress may support more informed decision-making by key stakeholders, as improved transparency can reduce uncertainty in decisions involving time and money. This approach also automates manual tasks, such as reminding key stakeholders about changes in a construction project. However, the subscription cost and the requirement for user training are barriers to the adoption of such an approach, particularly for smaller firms.

This centralized information management is also known as digital construction management platforms which are characterized by features such as integrated, cloud-based and these features help assist in the planning, coordination, monitoring of construction. Recent quantitative studies confirm the adoption of digital construction management platforms serve as a statistically significant predictor of overall project performance (Islam, 2020). While the adoption of digital construction management brings substantial benefits to the project, its deployment is often hindered by industry challenges such as data integration, cybersecurity risks, and the skill barriers to the use of platforms. It can be said that the transformation from a manual approach to digital construction management platform is not merely a technological upgrade, but a complex organizational transformation.

PROPOSED SYSTEM DEVELOPMENT

The proposed conceptual centralized information management system will be framed using the System Development Life Cycle (SDLC). SDLC was selected as the framework for the proposed system due to its structured, sequential nature. The compatibility of SDLC with construction information management is another reason it is being considered for the proposed system, as in this context the accuracy of information and audit trails are prioritized. This compatibility arises because the SDLC framework can ensure that user requirements are fully analyzed before implementing the system in the organization. In the SDLC, there are five stages in total: feasibility studies, system investigations, system analysis, system design, and implementation. These stages must be gone through one by one to ensure the systems developed are both technically feasible and align with the purpose of development in the first place, which is to enhance information management in a construction project. This research primarily focuses on the system design phase rather than the implementation phase.

Comparison between the current process and the new process

The key difference between the current and new processes is the transition from a reactive, manual workflow to an automated system. As shown in Figure 1, the current process requires quantity surveyors to record all project changes in Excel manually. In other words, the quantity surveyor acts as a bottleneck, keying the data from different channels into a spreadsheet. The flowchart also shows that communication among the various stakeholders in the current approach is not efficient enough due to the lack of a centralized platform where all stakeholders can view uploaded information and communicate through it.

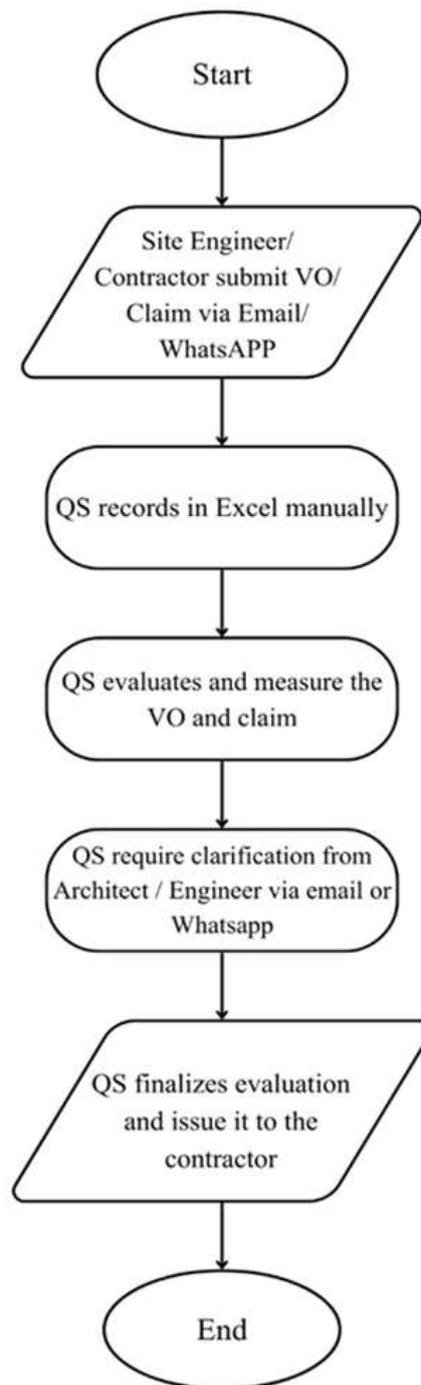


Figure 1 : Flowchart of current process

The introduction of a centralized platform for information management, such as Monday.com, reduces information fragmentation and provides a unified, structured channel for stakeholders to communicate and exchange information. It provides live visibility into progress to key stakeholders, so clients can see which stage each task is in through a real-time dashboard and workload tracking. This real-time workload tracking allows the project team to take immediate action when the project's progress shows any deviation from the planned progress (Kopsida and Brilakis 2020). The centralized platform also reduces administrative workload by automating tasks, such as sending deadline reminders to each stakeholder. This automation reduces latency in the manual approach and decreases the risk of human error. The client, which is one of the core members of a construction project, can

now make more informed decisions, as the real-time dashboards provide live tracking of project status and eliminate the ambiguity inherent in a manual approach. As illustrated in Figure 2, the proposed system can streamline the management of variation orders by serving as a centralized digital pipeline.

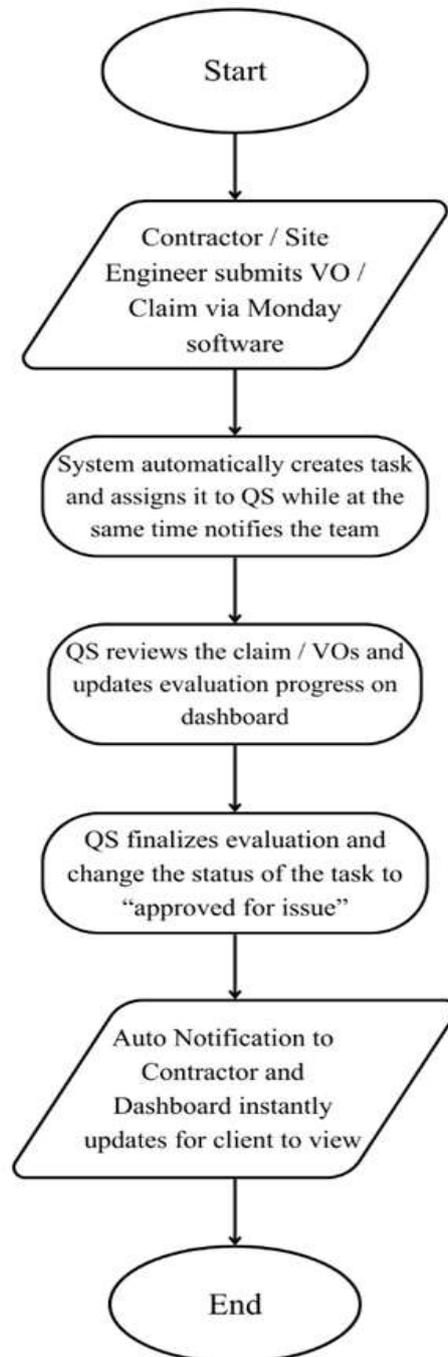


Figure 2: Flowchart of the new process

Benefits of the proposed system

The proposed system offers various benefits that enhance task management efficiency in construction projects. First, Monday.com enables centralized communication on a digital platform. Centralized communication helps

effectively address confusion and miscommunication caused by multiple document versions of the same information. In Monday.com, all discussions, attachments, comments, and instructions will be organized under a single task thread. The consolidation of communication channels reduces repetitive tasks and promotes structured document tracking environments. This ensures construction consultants can easily track and promptly assess the latest key information, which is a key factor in project success (Chen, Chang-Richards, Pelosi, Jia, Shen, Siddiqui, & Yang, 2022).

Secondly, the proposed system optimizes efficiency and time management within the consultancy workflow. One key feature of a centralized database is automated task creation. Before implementing such a system, all tasks, such as variation orders and claims, should be manually keyed in and processed in Excel by quantity surveyors. However, with automated task creation, the administrative workload for quantity surveyors decreased, allowing them to spend more time on high-value analytical tasks such as preparing feasibility studies for projects (Salleh et al., 2020). This transformation method not only speeds up the workflow but also reduces management risks, such as human error in repetitive administrative work.

Furthermore, the platform also provides real-time visibility and project transparency. Unlike the traditional method, there is a shared dashboard on the program's main page that shows live, updated activities. For instance, status indicators like "In Review", "Clarification Needed" and "Finalized" show the exact stage of each claim or variation order. Clients and other construction players can access the latest progress information without relying on manual reports or status requests. This feature promotes accountability within the team, as every user's actions and timelines are recorded and visible to the team. Consequently, this transparency fosters greater trust among clients and construction consultants and enhances a better working relationship on construction sites (Olanrewaju, Tan, & Kwan, 2017).

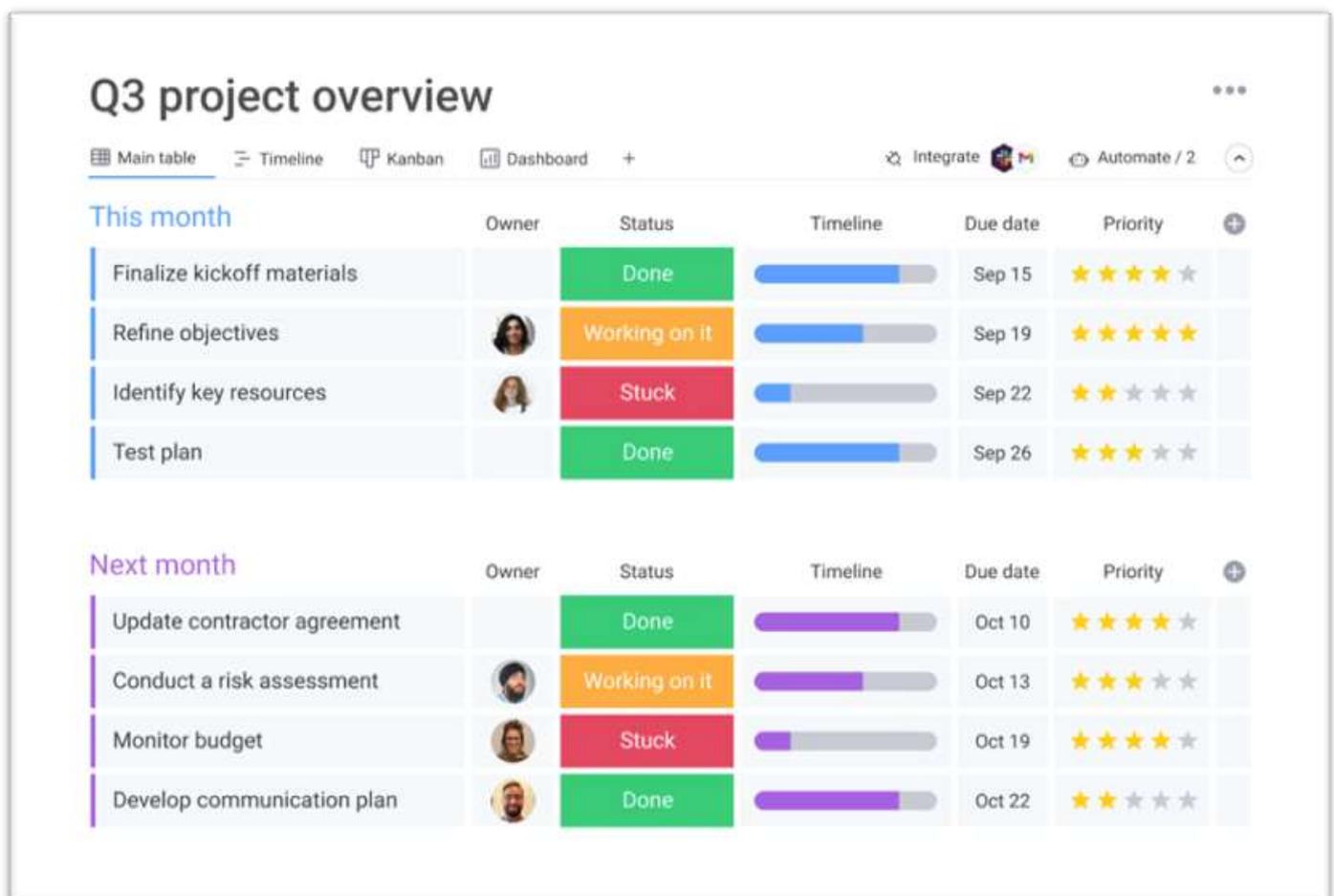


Figure 3 : Example user interface in the Monday program

Limitations of the Proposed System

The learning curve of the proposed system is one of its limitations, as most stakeholders in the current construction industry were not familiar with it. This necessitates a significant time investment, as users must complete a series of training sessions to utilize the program and achieve optimal project efficiency fully. The problem of stakeholders unfamiliar with the proposed system also led to another problem: resistance to change, as not all construction personnel are technically proficient with digital platforms (Bajpai & Misra, 2021). One strategy to mitigate this learning curve is to implement “phased adoption” in the organization. For instance, instead of rolling out the use of the centralized database company-wide, the proposed system can first be introduced to a single pilot team. The purpose is to ensure the proposed system meets the organisation’s requirements and that its implementation does not disrupt the organisation's workflow. However, overcoming this barrier requires genuine change management. Recent critical reviews state that running parallel both systems such as using the manual approach and operating the digital system simultaneously is an ineffective method for the firm to evolve (Nikmehr et al., 2021). To fully realize the benefits from the adoptions of digital system, the organization cannot simply just implement the software, it must instead execute a comprehensive digital transformation strategy that phases out legacy manual routines.

The second limitation is the cost of implementing the proposed system. Unlike traditional tools, whose costs are usually one-off and often involve perpetual licensing, the cost of the proposed system is based on a Software-as-a-Service (SaaS) subscription model. Users must pay monthly to use the software, creating a long-term financial commitment. This limitation becomes a barrier to the adoption of the proposed system, especially for small or medium-sized firms, as they often have tighter budgets (Nasir, Sahidi, & Hasim, 2024). Nonetheless, the financial barrier can be mitigated through government incentives designed to increase digitalisation in the construction industry.

Over-reliance on the system stability would be another limitation of the proposed system. As centralized information management software provides a unified communication channel between the various stakeholders, this also means that when the software experiences disruption, the entire workflow will be disrupted. A centralized database system means its server is cloud-based and depends fully on internet availability, which carries the risk of database downtime if errors occur. This limitation might be why the current construction environment still prefers the manual approach over the proposed system, as construction projects often have tight deadlines. Therefore, the scenario of cloud-based server downtime poses a significant operational vulnerability that does not exist with the manual approach.

Moreover, one big limitation of this study is the conceptual nature of the proposed system. As the norm in information management in the current construction industry remains a manual or semi-digitalised approach, this proposed system has not yet been deployed in a live construction environment; hence, the benefits discussed are theoretical and not empirically validated.

SIMULATED CASE STUDY

A simulated case study was conducted to validate the theoretical benefits of the proposed system. The simulation is based on a commercial redevelopment project over a three-month period, with the focus on processing approximately 50 variation orders. In this simulation, a comparison will be made between the traditional, fragmented method and the proposed centralized digital database. The evaluation is based on four quantitative key-performance indicators (KPIs), which are cycle time, data retrieval speed, error frequency, and administrative resource allocation.

Project Scope : Processing 50 VOs and its associated documentation over the 3 months period.

Data collection : Estimated time used on data tracking and error-rate baseline drawn from standard industry practices and insights from industry practitioners.

Evaluation Of Methods Performance

Performance Indicator	Manual Approach	Proposed System	Estimated Net Improvement
Average VO Cycle Time	~4.5 days per VO	~1.5 days per VO	66% faster processing
Data Retrieval Time	15-20 minutes per search	1-2 minutes per search	~90% reduction in search time
Administrative Workload	8 hours/week (data entry & tracking)	2 hours/week (automated logging)	6 hours saved per week
Error / Rework Frequency	Human-intensive approach may lead to gross errors.	Depending on network availability and power failure may lead to delay in VOS processing.	Gross errors can be spotted and corrected more easily but requires network stability, which is a requirement most organisations already achieved.

Analysis Of Findings

The manual approach requires an average of 4.5 days per VO largely due to the communication that is asynchronous and email responses that might delay. The proposed system reduces this VO cycle time to 1.5 days by using automated task assignments and notifications. For example, the system will automatically notify the quantity surveyor the moment contractor submit a claim and create a task in the dashboard of the system, which is able to eliminate the latent waiting periods between handoffs.

In manual approach, tracking down site-specific instructions and VO claims involved scrolling through unstructured WhatsApp group and cross-referencing isolated PDF files, taking up to 20 minutes per instance. The unified search function in the proposed system can reduce the retrieval time to under two minutes at the same time ensuring a clear audit trail for final account preparation. By automating the creation of tracking logs and dashboard updates, the centralised platform saves approximately 6 hours of repetitive administrative work per week. This reduction allows the quantity surveyor to focus more on high-value tasks such as cost planning and taking-off quantities, thereby optimizing operational efficiency.

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CONCLUSION

This study provides a conceptual framework for the digitalisation of construction information management, grounded in the SDLC. As the industry moves toward Construction Industry 4.0, changes are needed across more aspects of the construction industry, and information management was one of them, as there were more forms of information in a construction project due to the integration of more technologies. In analysing the limitations of the current manual approach, this study highlights that one of the key barriers to project efficiency is the fragmentation of information across different communication channels. The proposed system directly addresses this issue by serving as a central digital pipeline while automating workflows and providing live tracking of project progress.

The implementation of this system has several limitations, such as the cost of implementation, industry resistance to change, and over-reliance on system stability. Overcoming these financial and technical limitations is essential to increasing the industry adoption of the proposed system. With the advancement of other technologies, the integration of these technologies with the proposed system should also be studied to further the project's efficiency, which will help in the wider adoption of the proposed system.

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