Digital Document Control System for Post-Contract Management

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ABSTRACT

Post-contract document management is vital for cost control, variation evaluation, and claims management in construction projects. Nevertheless, most Quantity Surveying companies still use manual methods for drawing distribution, such as email and shared drives. The consequences of these methods are often confusion over document versions, remeasurement errors, and delays in processing variation orders, which have a negative impact on project financial performance. Although there have been digital and AI-based tools, the literature on their applicability to post-contract quantity surveying processes is limited and under-researched. This paper has used a workflow and system analysis, along with a dedicated literature review, to investigate current practices in manual document control and to develop and test a centralized Digital Document Control System (DDCS) on an AI-enhanced Procore platform. The results showed that the suggested digital workflow reduced manual cross-checking, increased drawing traceability, and improved the accuracy and efficiency of variation identification and remeasurement. The research provided a practical, scalable model for enhancing post-contract document control, thereby improving decision-making, reducing conflict, and increasing efficiency in project delivery.

Keywords: Digital Document Control System, Post-Contract Management, Quantity Surveying, Drawing Revisions, Construction Information Technology, Construction Digital, Built Environment

INTRODUCTION

Post-contract management is a key stage in construction projects and has a direct impact on ultimate cost control, variation management, and the resolution of claims and final accounts (Ashworth & Perera, 2018). For Quantity Surveyors (QS), interim valuations, remeasurement, and Variation Order (VO) assessment are all fundamentally based on accurate, updated, and completely traceable project documentation, especially construction drawings (Eadie, Browne, Odeyinka, McKeown, & McNiff, 2019). Inaccuracies or inaccessibility of documents may lead to financial errors, contested modifications, and project overruns, which ultimately affect the project's overall performance (Dosumu, 2017).

Although Building Information Modelling (BIM) and digital tools are increasingly adopted in the design and pre-construction phases, post-contract document administration continues to rely on manual or semi-digital processes. The most common are email-based delivery, shared network-based storage like Google Drive, and revision-tracking spreadsheets, all of which are highly susceptible to version confusion, file duplication, and human error (Whyte & Hartmann, 2017). This disparity between technology and industry practice leads to significant operational inefficiency. When architects and engineers provide frequent drawing revisions, QS must manually compare multiple drawing versions, which is both time-consuming and error-prone (Sacks, Eastman, Lee, & Teicholz, 2018). These incomplete workflows make reporting more difficult, postpone VO assessment, and undermine audit trails required to support claims, raising contractual and financial risk (Alaloul, Liew, Zawawi, & Kennedy, 2020).

The argument that these manual approaches are still in use points to an obvious research and practice gap. Whereas standards such as ISO 19650 outline the principles of information management in a Common Data

Environment (CDE), the application of these principles to post-contract quantity surveying processes is under-researched, particularly in drawing revision control and change quantification (British Standards Institution [BSI], 2018). Besides, although automated drawing comparison using artificial intelligence (AI) is beginning to take shape, it still needs to be incorporated into a document control system that meets QS-specific post-contract requirements (Kim, Lee, & Park, 2025).

Thus, the purpose of the paper is to explore operational issues related to manual document control in post-contract management and to propose and analyze a digital solution. In particular, it discusses how an in-house Digital Document Control System (DDCS), based on AI-powered drawing comparison and centralized workflow management, will streamline processes, increase accuracy, and improve decision-making among Quantity Surveyors, ultimately leading to more transparent and efficient project delivery.

Problem Statement

Even now, when the construction industry is developing rapidly, most operations, such as checking revised drawings and recording changes, are still done manually. In the case of quantity-surveying companies, this common practice results in version confusion, measurement errors, and delays in the post-contract preparation of variation orders (VOs) due to the presence of multiple inconsistent versions of the drawing files. The constant updates released by architects and engineers are hard to keep up with, and the information's inaccuracy will force the QS professional to spend more time verifying measurements, resolving discrepancies, and updating records. These problems directly impact cost control and claims because late or inaccurate measurements can lead to under- or over-claims, quarrels with contractors, and project delays (Disaratna, 2022).

The periodical changes in substation configuration description (SCD) files involved with construction and maintenance operations increases the complexity in managing version and reveals the drawbacks of the traditional manual methods used to support post-contract quantity surveying tasks. Adopting a version-control system, e.g., Subversion (SVN), was shown to improve the accuracy and traceability of data in the whole project life cycle (Wang, 2019). This, in turn, means that the implementation of a digital document control mechanism that would integrate automated drawing comparison should be investigated to support post-contract quality surveying operations. The proposed system has a potential to enhance accuracy and efficiency of remeasurement and variation-order preparation, enhance information flow among consultants and curb disagreements by improving cost management.

Review Of The Current Approach

Post-contract management is an essential stage of construction projects that involves contract administration, variation appraisal, progress and final payments, claims assessment, and project completion. These activities will depend on the availability of proper, reliable, and verifiable project documentation. With the increasing complexity of construction undertakings and the voluminous information they produce, the sector has increasingly abandoned solely manual documentation practices in favour of implementing digital document control systems (DDCS). The current segment provides an overview of post-contract document management practices by contrasting traditional and electronic methods, identifying their limitations, and offering a critical assessment of academics' views on their effectiveness in supporting the practice of quantity surveying.

Current Practices In Managing Documents In The Digital Age: Post-Contracting

In a significant percentage of construction projects, post-contract documentation is still controlled by old, decentralized systems, including emails, shared drives, and local servers. Even though these modalities are accessible and economical, they require individual users to name them properly and to store and keep records correctly. For quantity surveyors (QSs), such dependence has often created problems in finding the latest approved drawings for remeasurement or in establishing which documentation has contractual validity to support variation orders and claims.

More recently, practice has been moving towards centrally digital platforms, commonly known as Common Data Environments (CDEs). Such systems bring together all post-contract records, such as drawings, RFIs,

variation records, payment records, and handover records, into a single repository (BSI, 2018). This strategy is supported by ISO 19650, which provides clarity on how to name documents, manage and control their revisions, determine their status, and exchange information systematically throughout the project lifecycle, including the post-contract stage.

Some of the processes included in digital document control systems are workflow-based document submission, review, and approval. Such workflows largely automate approval histories and timestamps, thereby creating credible audit trails that support contractual compliance and resolve disputes, compared with the manual circulation of files through email (Eadie et al., 2019). Moreover, mobile-access cloud-based solutions allow site employees to save inspection reports and site images on-site, speeding up and improving the quality of information transfer and movement compared to paper-based systems (PlanRadar, 2023).

Limitations Of Existing Digital Document Control Systems

Although it can be seen that this demonstrates a demonstrable superiority of modern digital document control systems over conventional ones, this system still has several limitations, especially in the post-contract quantity surveying scenario. The main problem is that project information continues to be torn apart. However, even though DDCS are trying to centralize data, the use of parallel tools by separate stakeholders, e.g., email, spreadsheets, or individual BIM tools, is still common. Therefore, the multiplicity of documents and versions results in QSs more frequently relying on outdated drawings to make remeasurement or variation judgments (Sacks et al., 2018).

The other common weakness is the lack of proper document classification and inconsistent metadata. In practice, a large amount of data is uploaded without conformity to acceptable naming rules, revision history, and logical explanations of amendments. In the case of QSs, it prevents monitoring of drawing revisions, delays the appraisal of changes, and reduces the validity of the documents used as evidence in claims and in the final preparation of the account (BSI, 2018; Eadie et al., 2019).

Human and organizational issues also degrade system performance. Digital platforms do not require users to follow the disciplined information management roles and well-organized processes that traditional folder-based systems do. But opposition to change, lack of training, and enforcement often result in direct users going around the system altogether, thus reducing its efficacy (Whyte and Hartmann, 2017). Furthermore, recent research indicates that numerous DDCS are not specifically designed to facilitate post-contract QS activities. When preparing claims and final accounts, QSs continue to manually assemble and reconcile various documents, which limits the efficiency gains expected from digital systems (Ekanayake 2025).

Scholarly Views On Digital Document Control Systems

There is general agreement in the academic literature that digital document control systems may be a better way to manage information in the post-contract phase**.** However, their effectiveness depends less on technology than on governance and process integration. ISO 19650 is widely recognized as the broadest framework for managing project information, but the inconsistent use of contractual clauses often makes it difficult to realize the full benefits of the framework in practice (BSI, 2018; Sacks et al., 2018).

Another scenario researchers note is that although DDCS have been found to enhance document traceability and transparency, their support for post-contract activities (including variation valuation and claims handling) is often limited by interoperability problems and uneven data quality (Whyte & Hartmann, 2017; Ekanayake, 2025). The diffusion of artificial intelligence has recently been considered in document control, with the idea that AI-based tools may be used to identify risks and contract changes much more effectively. However, researchers warn that these tools are meant to complement, not replace, professional judgement because of issues of accuracy and legal reliability (Kim et al., 2025).

Tools and Methods Used in Digital Document Control

The existing practices in digital document control are mainly based on cloud-based management platforms to control documents, automate workflows, and enable access via mobile devices. These tools provide better version control, increased traceability, and more transparent audit trails than traditional approaches, all of which are necessary for effective post-contract administration (PlanRadar, 2023). These systems are increasingly interconnected with BIM systems to reconcile model information with contractual documentation in accordance with ISO 19650 specifications (BSI, 2018).

Moreover, new AI-based methods, including machine learning and natural language processing, are being explored to automate document classification, document comparison, and contract analysis. Although these technologies may save QSs manual labour, particularly in revision and claims documentation, current studies have highlighted that strong governance, high-quality data, and sound legal frameworks are required before widespread adoption can be realized (Kim et al., 2025).

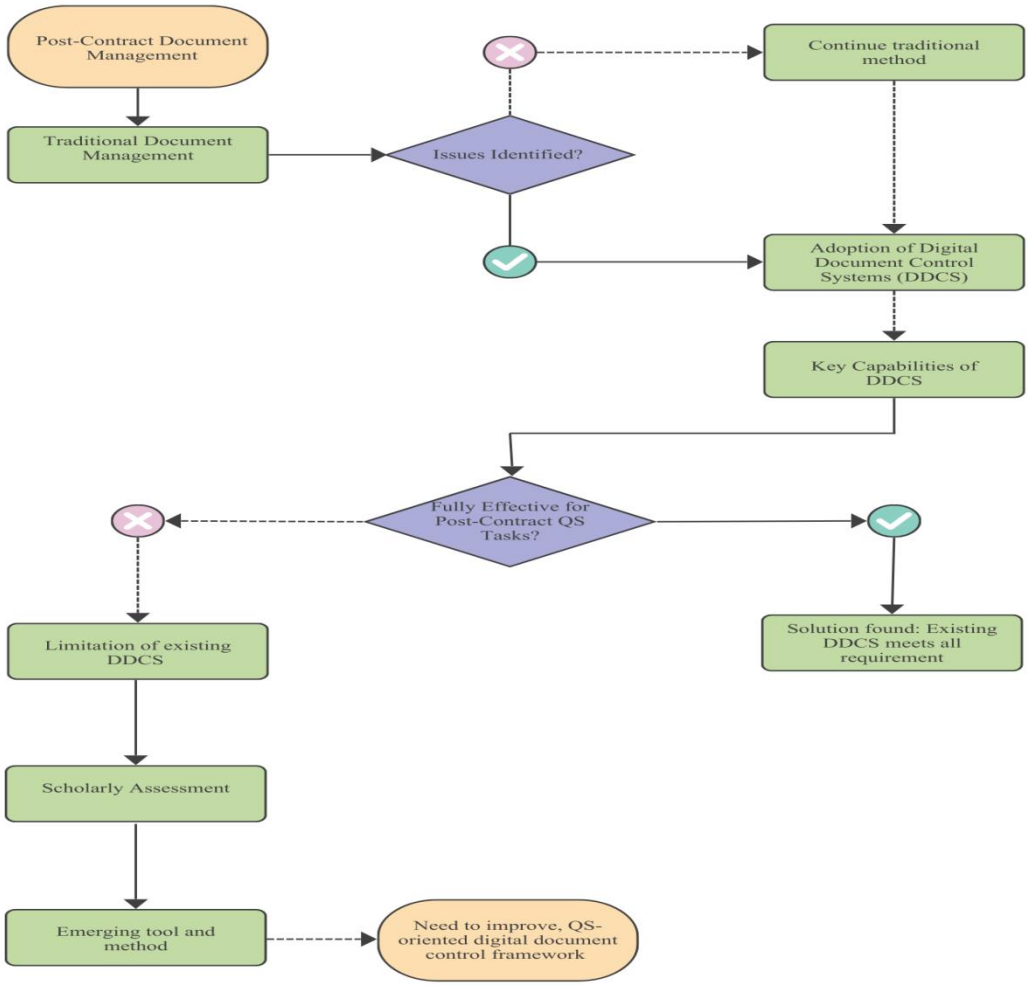

Figure 1. Overview of Post-Contract Document Management Practices and Limitations

Technological Solution And Available Tools

Digital Platforms in Construction Information Management

The management of project information in contemporary construction projects is becoming more digitized in the form of a Common Data Environment (CDE). A CDE represents a central repository which is used to store, handle and share project data like drawings, specifications, site records, requests of information (RFI) and variation documentation. The centralized environment implementation will secure that all stakeholders can

access the same verified set of documents at the project lifecycle (BSI, 2018). It is especially important in the post-contract phase, when the interim valuation, remeasurement, and appraisal of claims rely on the relevant and verifiable documentation.

Conventional methods of sharing files like email broadcasting and common drives often lead to duplications of files, old-fashioned sketches, and ambiguous history of approvals. Such issues present challenges to quantity surveyors in identifying the most recent approved revision as well as in defending variation orders. Document control platforms and digital platforms thus enhance accountability and transparency by adding revision control, approval processes and audit trails which are time-stamped.

Available Construction Document Management Systems

A number of cloud-based construction management systems are already in practice to operate as Common Data Environment (CDE). These systems aid in document storage in the central location, regulated information transfer, and shared communication among project members. The implementation of these platforms is consistent with the principle of the structured information management advocated in the ISO 19650, which focuses on the standardisation of document naming, document revision, and common access to project data at all project stages.

A popular platform is Procore which is a construction project management system that aims at helping to coordinate the field, project management, and track documents. The platform offers document stacking of revision and storage in a centralized location where users can be able to draw the updated drawings and access to the latest approved documentation. The document control systems based on clouds make information more accessible and less version confusions than the email-based distribution methods.

Autodesk Construction Cloud is another system that has been embraced and integrates the services of BIM 360. The platform is based on the combination of project documentation and Building Information Modelling (BIM) process and allows organizing models, tracking issues, and detecting clashes. BIM-related environments enable project teams to relate information in the graphical model to the corresponding documentation, aiding the coordinated decision-making process and enhanced teamwork (Sacks et al., 2018).

Oracle Aconex is a document management platform that is centered on formal communication and contract administration. The system focuses on organised transmittals, approvals, and records of audit communication, which are essential in infrastructure projects of large scale and those driven by compliance. The trend of digital document control systems that offer workflow approvals and time-stamped communication records enhance traceability and contractual accountability in the operation of projects (Eadie et al., 2019).

Despite the fact that all of the three platforms are centralized document management systems, they have varying operational focus. BIM-oriented system has a focus on design coordination and document-oriented systems have the focus on contractual compliance and tracking of communication. The appropriateness of any system thus relies on such needs of the project especially in post contract quantity surveying where there is a need to do a revision of the drawing, variation assessment, and claims reports.

Table 0.1 Comparison of Major Construction Document Management Platforms

Feature	Procore	Autodesk Construction Cloud / BIM 360	Oracle Aconex
Primary Focus	Construction coordination & drawing control	BIM model collaboration	Contractual document control
Common Data Environment	Yes	Yes	Yes

Drawing Revision Control	Automatic revision stacking	Model-linked updates	Strict document version control
Drawing Comparison	Automated overlay comparison	Mainly 3D clash detection	Manual comparison via transmittals
BIM Integration	Moderate	Very strong	Limited
Workflow Automation	Approval workflows & change events	Model-based issue tracking	Formal approval and transmittal workflows
Audit Trail	Good	Good	Very strong
Suitability for QS (VO & Remeasurement)	High	Moderate	Moderate–High
Ease of Use	User-friendly	Requires BIM familiarity	More procedural and documentation-heavy
Typical Projects	Building & commercial projects	BIM-intensive coordinated projects	Infrastructure & public sector projects

As it can be compared, the three platforms have centralized document control; however, the method of drawing revisions and contractual records is different. BIM-based systems put more emphasis on design coordination, whereas document-based systems focus on distribution and compliance tracking.

Selected System and Functional Justification

Procore is chosen as the platform of implementation of the research based on the comparison of the existing systems. The main problem that has been observed during this research is that, quantity surveyors have a problem of comparing revised drawings manually, which in most cases causes errors in measurements and slow preparation of variation orders.

Procore has an automated drawing comparison functionality that identifies the variation in revisions of drawings. The system superimposes two versions of the drawings and shows additions and deletions enabling the quantity surveyors to effectively pinpoint the dimensional and layout changes. The changes that were identified can be directly related to instructions, information requests, and change events, and create a history of cost implications that can be traced (Procore, 2025).

The storage of documents centrally is a factor that makes sure that the project stakeholders have the same approved drawings, hence no miscommunication and no confusion in versions. By automating workflow, it becomes possible to submit, review and approve of work using structured processes and time stamped logs provide audit trail to support contractual claims and justify variations. The reporting dashboards will also enable the stakeholders to view the documentation status in real-time (Procore, 2025).

Hence, Procore is not presupposed to be the sole digital solution but is taken as an appropriate implementation environment due to its drawing revision comparison feature that directly addresses the research issue of inefficient manual document verification in the post-contract quantity surveying.

Table 0.2 Comparative Analysis of Procore Tools

Tool	Strengths	Weaknesses
Procore Documents	- Centralized cloud storage reduces version confusion	- Requires stable internet

	- Easy access for all stakeholders	- Initial setup and folder structuring can be time-consuming
Procore Drawings	- Revision stacking ensures latest drawing is used - Easy visual navigation for QS	- Large files may load slower - Limited advanced markup tools compared to specialist CAD software
AI Drawing Comparison	-Detects changes automatically and quickly - Reduces human error in remeasurement	- Accuracy may depend on drawing quality - May miss complex structural/MEP changes not clearly represented
Workflow Automation	- Reduces administrative delays - Ensures compliance with approval procedures	- Custom workflow setup requires experienced admin - Over-automation may reduce flexibility
Analytics/ Reporting	- Generates real-time dashboards - Enhances transparency and audit readiness	- Data accuracy depends on correct input - Require additional subscription tier

Together, this digital ecosystem, particularly AI Drawing Comparison and centralized document control, eliminates version ambiguities, accelerates remeasurement, strengthens Variation Order justification, and creates a continuous, traceable record of changes that is readily available to all stakeholders of a project.

Proposed Digital Document Control Workflow

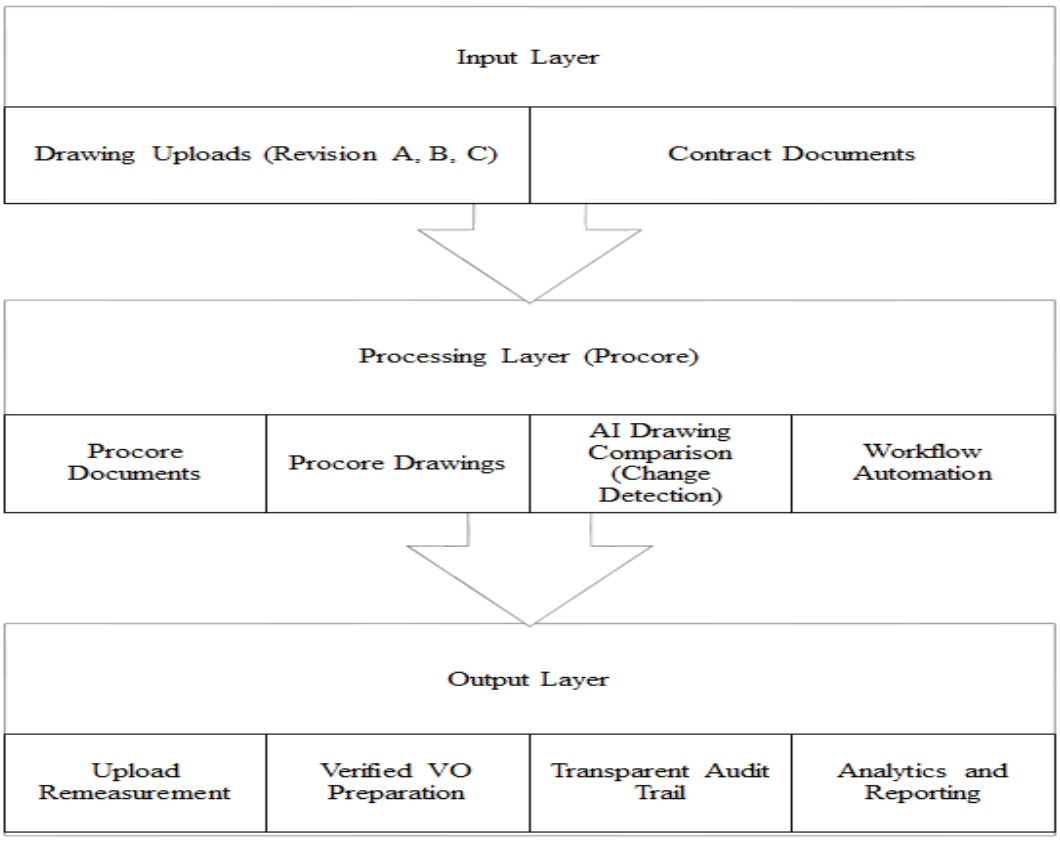

Figure 2. Conceptual Diagram of AI-Enabled Document Control Workflow

In the project, the workflow begins by uploading project drawings and documents to the central system, where the AI tool automatically identifies any changes. These changes are identified to assess their effects on measurements and costs, and are attributed to associated instructions or change events to form a trace. The automated approval process will ensure that only approved updates are used when valuing. Dashboards and reports will give stakeholders clear, real-time insight, guiding accountable, transparent, and accurate decision-making.

Proposed System Development

Pilot Study

A pilot testing exercise was conducted using a simulated post-contract project scenario in Johor Bahru to evaluate the functionality of the proposed Digital Document Control System. Under the manual system, the QS personnel took an average of 4.2 hours per set of drawing revision (10 sheets, including MEP and structural drawings) to engage in visual comparisons, measurements and error logging by use of PDF overlays and printed copies. This time was reduced to 1.5 hours to the digital workflow with AI-enhanced comparison through Procore, a 64 percent decrease that was mainly via automated change highlighting and OCR-based sheet recognition (Global CIO, 2025).

Comparison between the current process and the new process

The image drawing comparison proposed system uses an AI based program, which uses Optical Character Recognition (OCR) to obtain sheet number, revision number and draw annotation to be used followed by methods of image overlay, which then matches the drawings using key control points in order to provide pixel-based or vector-based differences. The possible ways are pattern recognition algorithms to identify additions/deletions (e.g., new MEP routes or structural changes) and automated change detection, revealing the variances in color overlays where red indicates deletions and green indicates additions in the complex drawings (Joy et al., 2025).

In complex MEP and structural sheets, performance is 90-100% accurate in change detection with high-resolution PDFs being used, as compared with traditional OCR (60% accuracy), with the difference coming in processing mutually dependent elements such as tolerances and symbols. The shortcomings are the inability to work with scans that are highly annotated or of lower quality, and requiring human verification of contractual interpretations to achieve legal reliability (Joy et al., 2025).

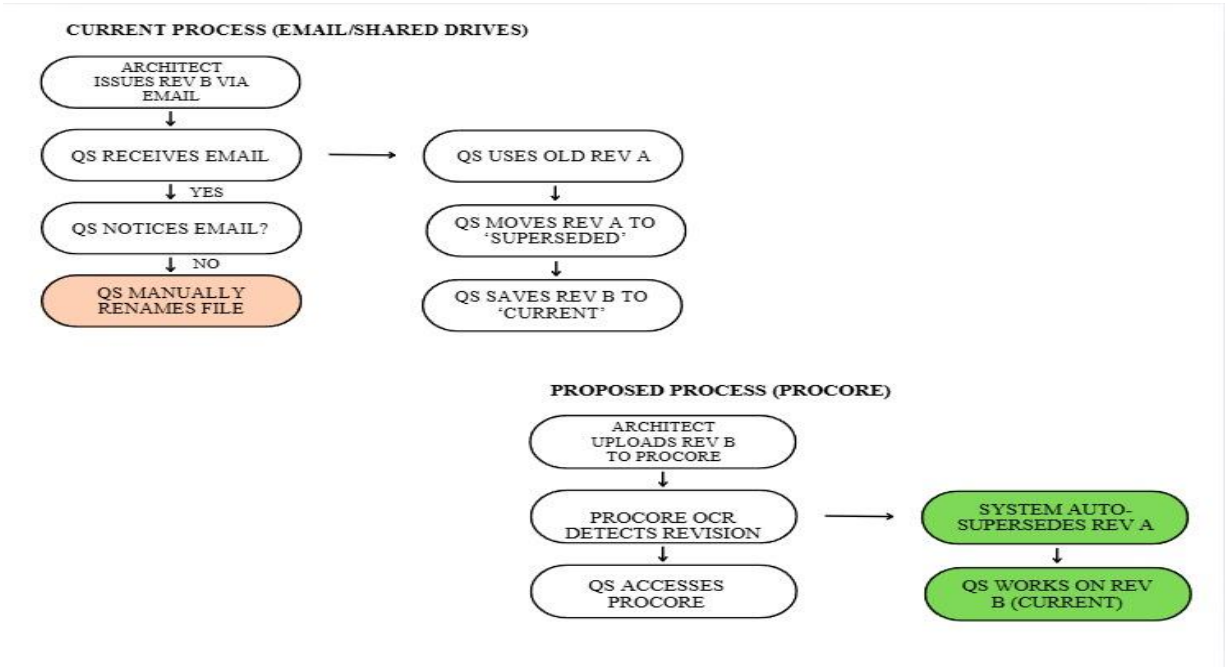

Figure 3. Process Flowchart

Benefit of the proposed system

The DDCS provides measured results associated with pilot study results, such as 64 percent less time spent in drawing comparisons and 35 percent efficiency improvements in document handling, as a whole. It provides 25-35% greater accuracy in estimation and quicker processing of variations, resulting in QS firms being able to support half the time when it comes to approval and having minimal rework due to version mistakes (Agarwal et al., 2016).

Live dashboards increase claims traceability which minimizes disputes through auditable records and recent industry standards indicate 15% productivity improvement and 6% cost reduction as a result of digital adoption (PEMS Digital Technologies, 2025).

Limitations of the Proposed System

In addition to technical limitations such as high dependence on internet connectivity and high licensing fees associated with SME QS firms, human and organizational factors such as resistance to change, intense training (2-4 weeks per user), and interruptions of the workflow during the migration process exist. Malaysian companies with QS personnel can avoid the system because of the established knowledge of email-based processes, which would widen the gaps in adoption (Sorce et al., 2021).

This is explained by the Technology Acceptance Model (TAM), in which perceived usefulness is the driving force behind uptake but perceived ease-of-use (PEOU) fails to work without specific training; phased pilots and stakeholder buy-in are the most important strategies in QS contexts. Traditional firms also require structured change management due to the implementation costs and culture that are resistant to change (Rinchin et al., 2024).

CONCLUSION

The proposed research sought to address the problem of assessing the effectiveness of digital document control systems in post-contracting work, with a focus on solving existing issues faced by Quantity Surveyor practitioners in dealing with revisions to drawings, remeasurement, and the generation of Variation Orders. The results suggest that existing post-contracting systems and procedures are highly manual and decentralised, leading to frequent issues with document versions, remeasurement errors, and poor variation control. A literature review and system analysis have shown that using an AI-driven digital platform such as Procore can greatly improve document tracing, accuracy, and related work processes.

The implications of this research include that, if an integrated digital document control system is developed and applied, enhanced post-contract decision-making, reduced conflict, and control over cost and time can be achieved in construction projects. Nevertheless, this research faces limitations in terms of implementation costs, reliance on a stable internet connection, potential resistance from project stakeholders, and a learning curve when advanced digital systems are involved. Future research work will have to address these aspects by developing better training methodologies for stakeholders, improving interoperability systems, and AI capabilities to cope with critical graphic change and contractual matters in construction projects

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