

# Digital Document Control System for Post-Contract Management

Farica Sung Wei Wen, Goh Sin Ru, Kieran Jingulam Quimson, Muhammad Adam Naqib Bin Md Nazli, Muhammad Farhan Harith Bin Mohamad Fauzi, Norhazren Izatie Mohd

Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia, 81300 Johor Bahru, Johor, Malaysia

DOI: <https://doi.org/10.47772/IJRISS.2026.10200161>

Received: 12 February 2026; Accepted: 18 February 2026; Published: 27 February 2026

## 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 include confusion over document versions, remeasurement errors, and delays in processing variation orders, all of which negatively impact 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 the inaccessibility of documents may lead to financial errors, contested modifications, and project overruns, ultimately affecting 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 this paper is to explore operational issues in 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 post-contract preparation of variation orders (VOs) due to multiple inconsistent versions of the drawing files. The constant updates from architects and engineers are hard to keep up with, and the inaccuracies 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).

Periodic changes to substation configuration description (SCD) files involved in construction and maintenance operations increase the complexity of managing versions and reveal 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 throughout the 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 the potential to enhance the accuracy and efficiency of remeasurement and variation-order preparation, improve 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 managed by outdated, decentralized systems, including email, 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 (QSSs), 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 processes in digital document control systems include 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 this demonstrates a clear 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 keeps being 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, remains common. Therefore, the multiplicity of documents and versions leads Qs to rely more frequently on outdated drawings when making 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 Qs, 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 users bypassing the system altogether, thereby 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, Qs 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 inconsistent use of contractual clauses often makes it difficult to realize its full benefits 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).

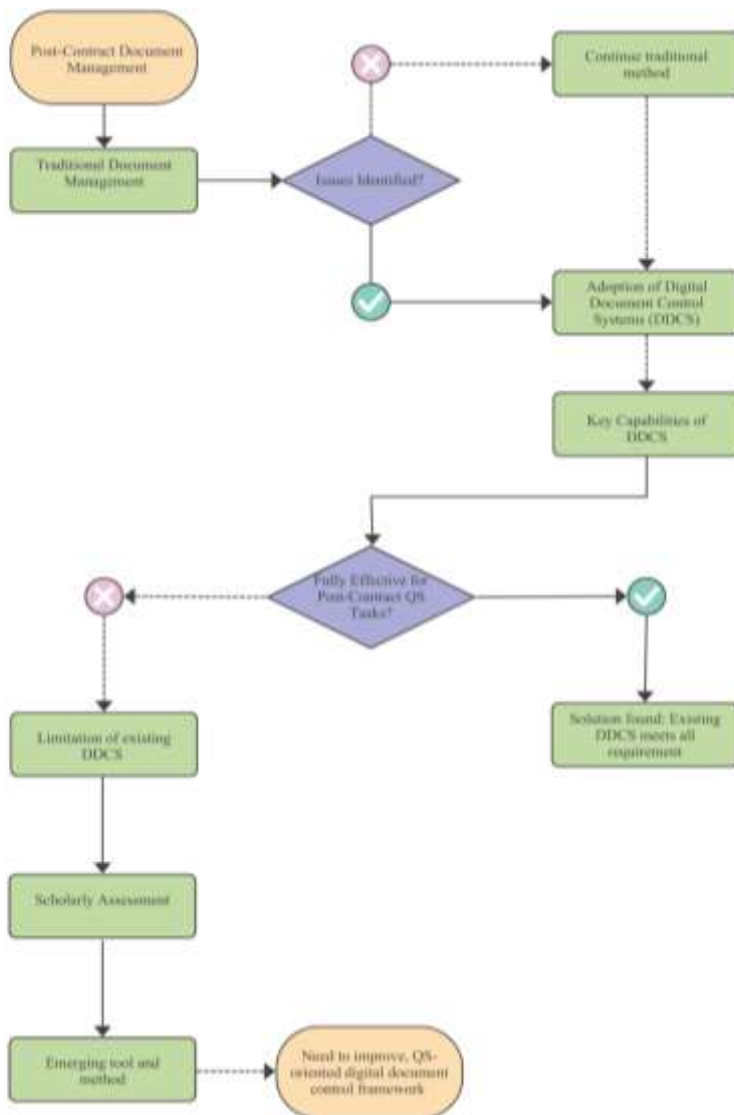


Figure 1. Overview of Post-Contract Document Management Practices and Limitations

### Technological Solution And Available Tools

#### Digital Platforms in Construction Information Management

The management of project information in contemporary construction projects is increasingly digitized through a Common Data Environment (CDE). A CDE is a central repository used to store, handle, and share project data such as drawings, specifications, site records, requests for information (RFIs), and variation

documentation. The centralized environment implementation will ensure that all stakeholders can access the same verified set of documents throughout 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, such as email broadcasting and shared drives, often lead to file duplication, outdated sketches, and an ambiguous approval history. Such issues pose challenges for quantity surveyors in identifying the most recent approved revision and defending variation orders. Document control and digital platforms thus enhance accountability and transparency by adding revision control, approval processes, and timestamped audit trails.

**Available Construction Document Management Systems**

A number of cloud-based construction management systems are already in use as Common Data Environments (CDEs). These systems aid in document storage in the central location, regulated information transfer, and shared communication among project members. The implementation of these platforms aligns with the principle of structured information management advocated in ISO 19650, which standardizes document naming, document revision, and common access to project data across all project stages.

A popular platform is Procore, a construction project management system that aims to help coordinate field operations and project management, as well as track documents. The platform provides document revision and storage in a centralized location, enabling users to create updated drawings and access the latest approved documentation. Cloud-based document control systems make information more accessible and reduce version confusion compared to email-based distribution methods.

Autodesk Construction Cloud is another system that has been embraced and integrates BIM 360 services. The platform combines project documentation with the Building Information Modelling (BIM) process to enable model organization, issue tracking, and clash detection. BIM-related environments enable project teams to relate information in the graphical model to the corresponding documentation, aiding coordinated decision-making and enhancing teamwork (Sacks et al., 2018).

Oracle Aconex is a document management platform focused on formal communication and contract administration. The system focuses on organized transmittals, approvals, and records of audit communication, which are essential for large-scale infrastructure projects and those driven by compliance. The trend toward digital document control systems that offer workflow approvals and timestamped communication records enhances traceability and contractual accountability in project operations (Eadie et al., 2019).

Despite all three platforms being centralized document management systems, they have varying operational focuses. BIM-oriented systems focus on design coordination, while document-oriented systems focus on contractual compliance and communication tracking. The appropriateness of any system thus relies on the project's needs, especially in post-contract quantity surveying, where revisions to drawings, variation assessments, and claims reports are required.

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	Automatic revision	Model-linked updates	Strict document version

Control	stacking		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 can be seen, the three platforms have centralized document control; however, the methods for drawing revisions and contractual records differ. 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 for implementing the research based on comparisons with existing systems. The main problem observed during this research is that quantity surveyors struggle to compare revised drawings manually, which in most cases leads to measurement errors and slow preparation of variation orders.

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

Centralized document storage ensures that project stakeholders have the same approved drawings, preventing miscommunication and confusion across versions. By automating workflows, it becomes possible to submit, review, and approve work using structured processes and time-stamped logs that provide an audit trail to support contractual claims and justify variations. The reporting dashboards will also enable stakeholders to view documentation status in real time (Procore, 2025).

Hence, Procore is not presupposed to be the sole digital solution but is considered an appropriate implementation environment due to its drawing revision comparison feature, which directly addresses the research issue of inefficient manual document verification in 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 - Initial setup and folder structuring can be time-

	- Easy access for all stakeholders	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 an 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**

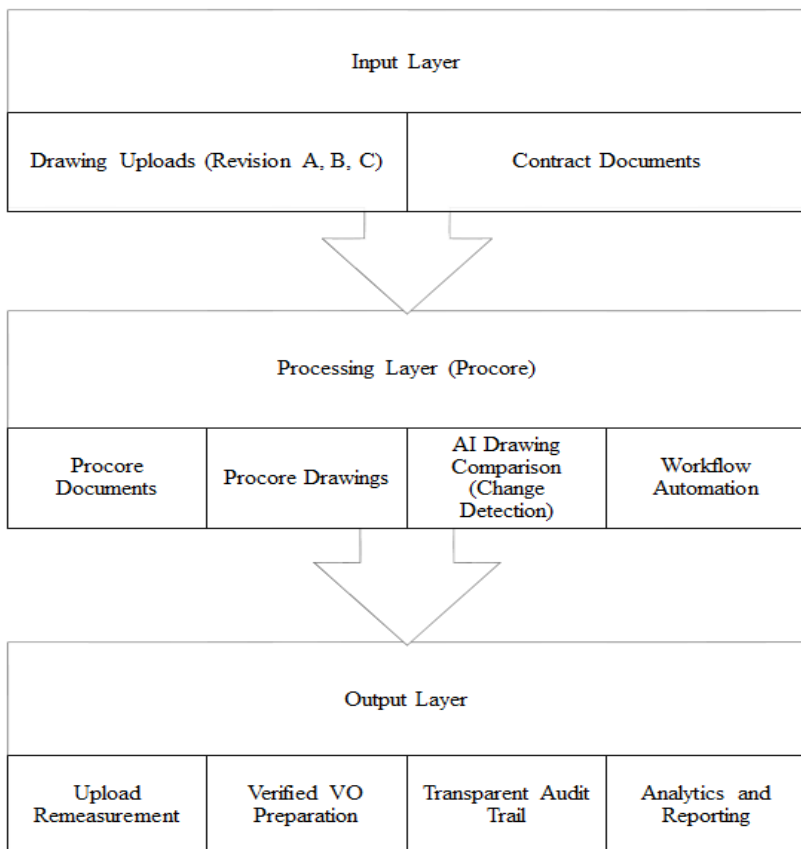


Figure 2. Conceptual Diagram of AI-Enabled Document Control Workflow

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 provide stakeholders with clear, real-time insight, enabling accountable, transparent, and accurate decision-making.

### Proposed System Development

#### Pilot Study

A pilot test was conducted in Johor Bahru using a simulated post-contract project scenario 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 revisions (10 sheets, including MEP and structural drawings) to conduct visual comparisons, measurements, and error logging using PDF overlays and printed copies. This time was reduced to 1.5 hours for the digital workflow with AI-enhanced comparison through Procore, a 64 per cent decrease, mainly through 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 that uses Optical Character Recognition (OCR) to obtain the sheet number, revision number, and drawing annotation, followed by methods of image overlay, which then match the drawings using key control points to provide pixel-based or vector-based differences. Possible approaches include pattern recognition algorithms to identify additions/deletions (e.g., new MEP routes or structural changes) and automated change detection, revealing variances in colour 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, compared with traditional OCR (60% accuracy), with the difference due to processing mutually dependent elements such as tolerances and symbols. The shortcomings include the inability to work with highly annotated or low-quality scans and the need for human verification of contractual interpretations to achieve legal reliability (Joy et al., 2025).

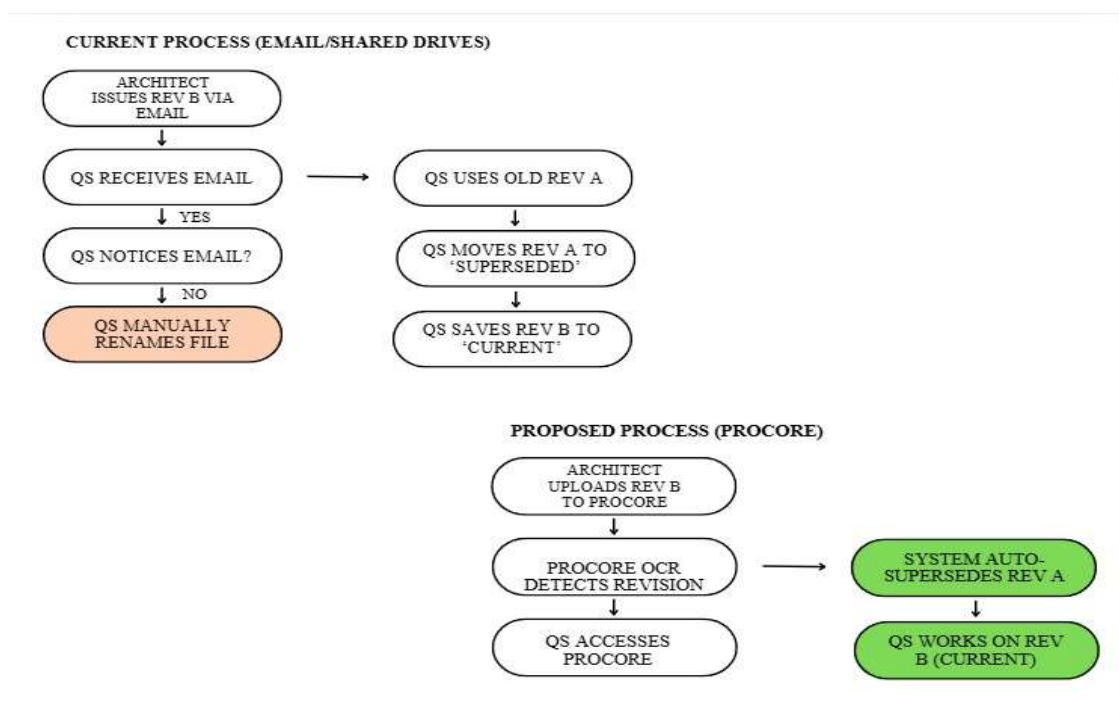


Figure 3. Process Flowchart

## Benefits of the proposed system

The DDCS provides measured results from the pilot study, such as 64 per cent less time spent drawing comparisons and 35 per cent efficiency improvements in document handling. It provides 25-35% greater accuracy in estimation and quicker processing of variations, enabling QS firms to support approval in half the time and to incur minimal rework due to version mistakes (Agarwal et al., 2016).

Live dashboards increase claims traceability, minimizing 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 reliance on internet connectivity and high licensing fees associated with SME QS firms, human and organizational factors, including resistance to change, extensive training (2-4 weeks per user), and workflow interruptions during the migration process, also exist. Malaysian companies with QS personnel can avoid the system because of their established knowledge of email-based processes, which would further widen adoption gaps (Sorice 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) requires 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 implementation costs and a culture 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 decentralized, 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.

## ACKNOWLEDGEMENT

This article is part of research FRGS/1/2023/SSI02/UTM/02/4, Minimising Dispute Occurrence Framework Through Building Information Modelling, Fundamental Research Grant Scheme, R.J130000.7852.5F628, Ministry of Education.

## REFERENCES

1. Agarwal R, Chandrasekaran S, Sridhar M (2016). Imagining construction's digital future. <https://www.mckinsey.com/capabilities/operations/our-insights/imagining-constructions-digital-future>
2. Alaloul, W. S., Liew, M. S., Zawawi, N. A. W. A., & Kennedy, I. B. (2020). Industrial Revolution 4.0 in the construction industry: Challenges and opportunities for stakeholders. *Ain Shams Engineering Journal*, 11(1), 225–230. <https://doi.org/10.1016/j.asej.2019.08.010>

3. Ashworth, A., & Perera, S. (2018). *Cost studies of buildings* (6th ed.). Routledge.
4. British Standards Institution. (2018). \*BS EN ISO 19650-1: Organization and digitization of information about buildings and civil engineering works — Information management using building information modelling (BIM)\*.
5. Disaratna, V. (2022). Performance management of contractor's quantity surveyors through the use of proper documents and records. In *Proceedings of the 12th International Conference on Sustainable Built Environment*.
6. Dosumu, O. S. (2017). Impact of design errors on variation cost of selected building project in Nigeria. *Journal of Construction Engineering, Management and Innovation*, 1(1), 1–12.
7. Eadie, R., Browne, M., Odeyinka, H., McKeown, C., & McNiff, S. (2019). BIM implementation throughout the UK construction project lifecycle: An analysis. *Automation in Construction*, 36, 145–151. <https://doi.org/10.1016/j.autcon.2019.01.023>
8. Ekanayake, G. (2025). Adequacy of document management systems for post-contract quantity surveying roles. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 17(1), 04521001.
9. Rinchen S, Banihashemi S, Alkilani S (2024). Driving digital transformation in construction: Strategic insights into building information modelling adoption in developing countries. <https://doi.org/10.1016/j.plas.2024.100138>
10. Joy P. (2025). AI for Construction Drawings: The Ultimate End of Error-Prone Takeoffs, Missed Details, and Slow Bids. <https://www.infrd.ai/blog/ai-for-construction-drawings>
11. Kim, E. W., Lee, S., & Park, M. (2025). Development of an automated construction contract analysis framework using artificial intelligence. *Buildings*, 15(3), 412. <https://doi.org/10.3390/buildings15030412>
12. PEMS Digital Technologies Pvt Ltd (2025). From Paper to Cloud: How Smart Construction Companies Are Winning with Digitalization. <https://www.linkedin.com/pulse/from-paper-cloud-how-smart-construction-y7nmf>
13. PlanRadar. (2023). Construction document management: Best practices and digital solutions. Industry Report. Retrieved from <https://www.planradar.com>
14. Procore. (n.d.-a). Compare drawing revisions. Procore Support. Retrieved November 30, 2025, from <https://support.procore.com/products/online/user-guide/project-level/drawings/tutorials/compare-drawing-versions>
15. Procore. (2025). Construction drawing management software. Procore. Retrieved November 30, 2025, from <https://www.procore.com/project-management/drawings>
16. Procore. (2025). Compare documents in the document management tool. Procore Support. Retrieved November 30, 2025, from <https://support.procore.com/products/online/user-guide/project-level/document-management/tutorials/compare-documents-in-the-document-management-tool>
17. Procore. (2025). Procore advances the future of construction with new AI innovations. Retrieved from <https://www.procore.com/press/procore-advances-the-future-of-construction-with-new-ai-innovations>
18. Sacks, R., Eastman, C., Lee, G., & Teicholz, P. (2018). *BIM handbook: A guide to building information modeling* (3rd ed.). John Wiley & Sons.
19. Sarkar K (2025). Implementation complete paperless digital construction process for Real Estate Industry. <https://globalcio.com/cases/15817/>
20. Sorce J, Issa R. (2021). Extended Technology Acceptance Model (TAM) for adoption of Information and Communications Technology (ICT) in the US Construction Industry. 26, 227-248 [10.36680/j.itcon.2021.013](https://doi.org/10.36680/j.itcon.2021.013)
21. Wang, G. (2019). Design and development of SCD file control system based on correlation interval decoupling. *Automation in Construction*, 103, 188–199. <https://doi.org/10.1016/j.autcon.2019.03.015>
22. Whyte, J., & Hartmann, T. (2017). How digitizing building information transforms the built environment. *Building Research & Information*, 45(6), 591–603. <https://doi.org/10.1080/09613218.2017.1324726>