International Journal of Scientific Engineering and Research (IJSER)
ISSN (Online): 2347-3878
SJIF (2024): 6.623

Transforming Construction Document Control with Automation and APIs

Akhil Ubale[1], Dr. Sumedh Mhaske[2]

[1]M Tech Student, VJTI, Civil and Environmental Engineering Department
Email: *ubaleakhil890[at]gmail.com*

[2]Associate Professor, VJTI, Civil and Environmental Engineering Department
Email: *symhaske[at]ci.vjti.ac.in*

Abstract: ***Efficient handling of documents remains a significant challenge in today's construction sector. Conventional methods ranging from paper-based records to disorganized digital files often lead to confusion, inefficiencies, and inflated project costs. This paper proposes a streamlined, automated document management approach using an Application Programming Interface (API)-based framework powered by Google Drive. The system enables real-time, organized access to critical documents for all stakeholders' engineers, contractors, architects, and clients while supporting seamless version control, role-based access, and detailed activity tracking. When tested in a real-world construction project, the solution considerably reduced delays and enhanced team coordination. With automation in place, essential documents were easy to retrieve, and communication gaps were minimized. The outcome was a faster, more transparent, and more accountable workflow that kept the project aligned with budget and timeline expectations.***

Keywords: Construction Management, Document Control, Automation, API Integration, Google Drive API

1. Introduction

In construction projects under the Architecture, Engineering, and Construction (AEC) domain, documentation serves as the foundation for defining scope, setting deliverables, and guiding execution. These include key documents such as technical specifications, quality and safety records, communication logs, and legal contracts. Given the involvement of diverse stakeholders and the multidisciplinary nature of projects, an effective system for managing these documents is vital. An efficient Document Management System (DMS) ensures structured storage, timely updates, and controlled sharing, which ultimately leads to quicker decisions and improved collaboration across teams.

However, many construction workflows still rely heavily on outdated, paper-based documentation practices. Project-related documents often emerge from disconnected stages such as design, tendering, approval workflows, inspections, and change orders. The lack of a centralized and automated method makes document updates cumbersome, resulting in version mismatches and operational setbacks. As projects become more complex, the drawbacks of these traditional systems grow more severe. Challenges like poor revision tracking, inaccessible records, and unauthorized access can cause on-site mistakes, rework, and disputes—leading to cost and time overruns.

Studies highlight that ineffective documentation is not merely a clerical issue but a major source of project inefficiencies. For instance, research indicates that nearly 60% of construction projects in India experience budget and schedule overruns, with poor document handling being a central cause. This underscores the urgent need to transition from manual systems to smart, automated solutions. In response to these issues, the paper presents a cloud-based, API-enabled document control system utilizing Google Drive's integration capabilities. Such automation allows real-time document access, streamlined permissions, version history tracking, and reduced errors. The proposed system demonstrates how digital transformation in document management can enhance transparency, minimize miscommunication, and significantly improve overall project delivery.

2. Literature Survey

The rapid advancement of digital technologies has significantly altered how data is acquired, stored, and analyzed across industries. Roussev et al. (2016) pointed out that traditional evidence gathering methods are often inefficient, primarily relying on client-side devices. Their study introduced a novel method that utilizes official cloud APIs for data acquisition, providing a more scalable, verifiable, and maintainable alternative to manual practices, particularly within the field of digital forensics.

In the construction sector, Hassan et al. (2020) developed a system that applies machine learning and Natural Language Processing (NLP) to automate the identification of contractual clauses. Their analysis revealed that Support Vector Machines (SVM) were particularly effective, streamlining the contract review process and reducing human error and time consumption.

Abbasi et al. (2020) explored the reasons behind frequent delays in Iranian construction projects. Their investigation, based on expert interviews and surveys, revealed that financial instability among contractors was the primary issue. This finding emphasizes the importance of strategic contractor selection and robust financial planning.

In Malaysia, Yap et al. (2021) surveyed industry professionals to identify delay triggers in construction. Their study concluded that poor planning, unplanned client changes, inefficient site management, and financial

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mismanagement were major causes—highlighting the urgent need for stronger project management frameworks.

In the realm of software engineering, Raatikainen et al. (2021) assessed API development practices in Finnish software companies. While APIs were widely adopted, challenges persisted in technology selection and user experience, underlining the need for strategic API management integration into overall product planning.

Tariq et al. (2023) examined the interconnectedness of project delays and stakeholder conflicts. Their analysis, using Jenks optimization, indicated that financial delays, change orders, and communication gaps often escalate into significant disputes—underscoring the value of proactive conflict mitigation strategies.

Daoud et al. (2023) analyzed delay and cost overrun factors in Egyptian mega projects. Their work pointed to poor planning and payment delays as major contributors and advocated for early stakeholder engagement and the use of digital project management tools.

Finally, Abdallah et al. (2024) addressed miscommunication in Saudi construction projects. Their study found that poor team coordination and inadequate documentation were key contributors to delays and quality issues. They recommended initiating robust communication protocols early in the project cycle to counter these problems.

3. Research Methodology

A systematic review of the literature (including peer-reviewed journals, industry case studies, conference proceedings, and technical reports) forms the foundation of this study. This research adopts a mixed-method approach, combining qualitative insights with quantitative measurements to assess the automation of document control in construction using API-driven tools. The methodology involves the development of a thematic analysis framework, supported by a case study, to evaluate improvements in document workflows.In this study, the Google Drive API was selected as the core technology for automation due to its widespread adoption, flexibility, and integration capabilities. A systematic literature review was conducted to identify gaps in traditional document control systems, the impact of document delays on construction projects, and the advantages of cloud-based automation. In parallel, a real-time pilot implementation was undertaken to validate the theoretical findings.

The study follows a structured approach comprising three phases:

- Phase 1: Identification of challenges in existing document management systems through a review of previous studies.
- Phase 2: Development of an API-based framework for automated document storage, retrieval, notification, and version control.
- Phase 3: Implementation of the framework on a live construction project and evaluation of performance indicators before and after automation.

3.1 Data Collection

The data collected for this research includes documents and resources essential for analyzing and automating construction processes. Contract Documents, such as technical specifications, outline the project scope, materials, methods, and performance standards, serving as a baseline for compliance and quality assurance. Architectural, Structural, and MEP (Mechanical, Electrical, and Plumbing) Drawings provide detailed insights into design elements, structural integrity, and service layouts, ensuring all project components are well coordinated. Additionally, construction-related checklists covering quality checks, safety protocols, and progress monitoring are gathered to understand workflows and identify areas for process optimization. Together, these datasets enable comprehensive analysis for automation and performance improvement.

3.2 Google Drive API

The Google Drive API enables developers to build applications that interact with Google Drive, Google's cloud storage platform. With this API, you can create apps that allow users to store, retrieve, or manage files on their Drive accounts. For example, you could design an app that lets users upload documents to Google Drive, organize them into folders, or download files directly from their storage.

3.3 API Based Framework

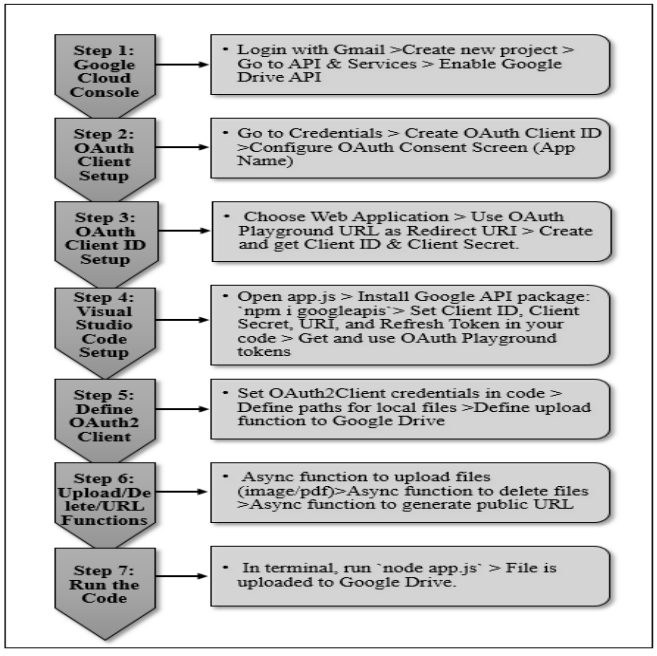

Figure 1: Google API based Framework

3.3 Libraries Installed

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Table 1: Libraries Required

Sr No.	Library	Install via pip	Purpose
1	streamlit	pip install streamlit	Web app UI framework
2	pandas	pip install pandas	Data manipulation and display
3	google-auth	pip install google-auth	Authentication with Google APIs
4	google-auth-oauthlib	pip install google-auth-oauthlib	OAuth2 authentication flow
5	google-auth-httplib2	pip install google-auth-httplib2	Transport for OAuth2 with Google
6	google-api-python-client	pip install google-api-python-client	Access Google Drive and Gmail APIs
7	email (standard lib)	(built-in)	Constructing email messages
8	uuid (standard lib)	(built-in)	Generating unique IDs
9	datetime (standard lib)	(built-in)	Working with timestamps
10	os, io, json, base64	(built-in)	File I/O, encoding, and general utilities

3.4 Case Study

Effective document management is crucial for ensuring smooth operations on construction sites. However, traditional paper-based documentation methods often lead to inefficiencies, miscommunication, and delays. This study identifies key issues observed on-site, highlighting the impact of outdated document handling processes.

1) Delay due to revised drawings not being circulated in hardcopy to the site team.

In traditional construction workflows, delays often occur when revised drawings are not promptly circulated to the site team in hardcopy format. This leads to miscommunication, rework, and project slowdowns. To address this, the automated cloud-based document management framework can ensure instant access to the latest drawings using Google Drive API and real-time notifications. By uploading revised drawings to a structured cloud folder and automating alerts via email, site teams can instantly access updated documents, reducing errors and improving project timelines.

Table 2: Time Delay due to Rework

Category	Details	Time
Time Delay	Demolition of incorrect beam	3-4 hours
	Debris removal	2-3 hours
	Reinforcement checking & fixing	4 hours
	Formwork reinstallation	6 hours
	Re-casting the beam	2 hours
	Strength gain & curing delay	7 days
	Total Delay	8 Days

Table 3: Extra Cost due to Rework.

Category	Details	Cost
Material Wastage	Concrete wasted (5cum)	₹ 25,000
Additional Costs	Formwork removal & reinstallation labor	₹ 5,000
	Additional site labor & management costs	₹ 5,000
	Extra Cost	₹ 35,000.00

2) Repeated queries from billing engineers to the site team regarding checklists at the end of the month.

In traditional construction billing processes, billing engineers frequently request checklists from the site team at the end of each month, leading to work interruptions and delays. These repeated queries arise due to unstructured document storage and manual retrieval methods. The automated cloud-based document management framework resolves this by storing checklists in a centralized cloud repository using Google Drive API. With a structured folder system and search functionality, billing engineers can instantly retrieve checklists without site team involvement, reducing delays, improving efficiency, and enhancing overall project workflow.

Table 4: Comparison w.r.t Traditional Method for 2nd Issue

Factor	Traditional Hardcopy Method	Automated Cloud-Based Approach
Checklist Retrieval	Manually search through paper files (10-15 min)	Search in seconds using Drive API (5 min)
Work Interruption	Frequent, affecting productivity	Minimal (Billing engineer accesses it directly)
Data Organization	Unstructured, difficult to track	Well-organized in folders (Year > Project > Checklist)
Chance of Losing Documents	High (misplaced or damaged)	Zero (Cloud storage with backup)

3) Conflict between client engineers and contractor engineers due to the unavailability of technical specifications on-site in real-time.

Conflicts between client engineers and contractor engineers often arise when technical specifications are not readily available on-site, leading to misinterpretations, work stoppages, and disputes. Traditionally, engineers rely on printed documents, which can be outdated or misplaced. The automated cloud-based document management framework eliminates this issue by storing technical specifications in a structured cloud repository using Google Drive API. With real-time access via mobile or tablet devices, both client and contractor engineers can instantly retrieve the latest specifications, ensuring clarity, reducing disputes, and improving on-site decision-making efficiency.

Table 5: Comparison w.r.t Traditional Method for 3rd Issue

Factor	Traditional Hardcopy Method	Automated Cloud-Based Approach
Access to Specifications	Limited; documents remain in office	Available on mobile/tablet via cloud
Argument Resolution Time	30-60 minutes per dispute	5 minutes (Quick access to specs)
Chance of Misinterpretation	High (Contractor may refer to outdated methods)	Low (Latest version always accessible)

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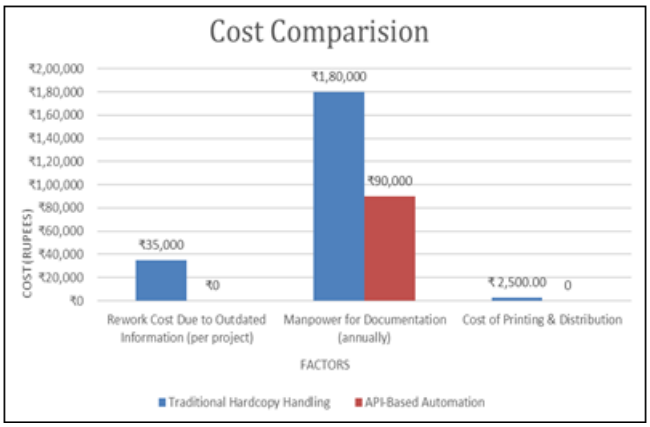

Figure 2: Time Comparison for 1st case study

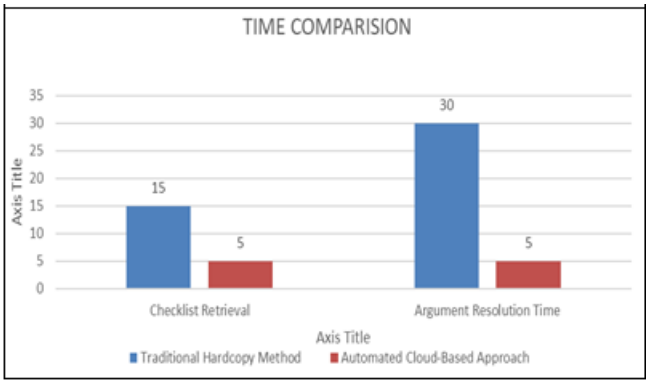

Figure 3: Time Comparison for taken case study

The case study findings confirm that an API-based automation framework significantly enhances document management efficiency. By reducing time delays and unnecessary expenditures, the system not only improves collaboration and accuracy in construction projects but also contributes to sustainable and cost-effective project management. Furthermore, the reduction in manpower requirements highlights the long-term viability of automation in the construction industry.

4. Result and Discussion

The implementation of a cloud-based documentation system has significantly improved efficiency in managing construction-related documents. The traditional hardcopy method often led to delays due to the time required to manually retrieve and verify documents. This inefficiency resulted in frequent work interruptions, miscommunication, and financial losses. With the automated cloud-based approach, documents such as checklists, technical specifications, and revised drawings are now systematically stored and instantly accessible. This has reduced the time required for document retrieval from 20–30 minutes to 2–3 minutes per query, leading to a substantial reduction in work disruptions. The adoption of cloud storage has also eliminated the risk of document misplacement or damage, which was a common issue with physical records. Additionally, the structured organization of files has improved data traceability, reducing confusion and conflicts between stakeholders such as client engineers and contractors. This has led to better adherence to project specifications and minimized errors in execution. Overall, the implementation of this framework has enhanced operational efficiency, reduced documentation errors, and optimized cost and time management in construction projects.

Table 4: Comparison between Traditional way and API Approach.

Sr No.	Factor	Traditional Hardcopy Storage	Automated Google Drive (API)
1	Time for Document Retrieval	5-30 minutes (manual search in files)	Instant (Few seconds) via search & filters
2	Revision Management	Delays due to circulation & printing	Real-time updates with version history
3	Storage & Accessibility	Limited to physical location	Access from anywhere (Cloud)
4	Cost of Printing & Distribution	₹500-₹5000/month (paper, ink, courier)	Zero printing costs
5	Legal & Technical Reference	Miscommunication due to missing docs	Instantly share technical specs
6	Search ability	Manual lookup needed	OCR-enabled search for text in PDFs
7	Backup & Security	Risk of fire, loss, wear & tear	Automatic cloud backup, no data loss
8	Notifications & Alerts	No automatic notifications	Email alerts for new uploads
9	Site Execution Delays	Frequent stoppages due to lost papers	Reduces delays due to missing drawings

5. Conclusion

Improving document management practices in the construction industry is critical to enhancing project efficiency and coordination. Although advanced technologies such as Block chain and Heritage Building Information Modelling (H-BIM) present significant benefits, their cost and technical demands often limit their applicability, particularly for small to mid-scale projects. This highlights the urgent need for more accessible and scalable alternatives that can be tailored to diverse project requirements. The proposed framework addresses these challenges by introducing an automated, cloud-integrated document management system utilizing Google Drive APIs with OAuth 2.0 authorization. This setup effectively eliminates manual errors, speeds up access to documents, and improves information dissemination through an integrated email notification system. Key project documents such as updated drawings, checklists, and technical files can be instantly shared, ensuring all stakeholders remain informed and aligned. By automating core document-related tasks and ensuring secure, organized digital storage, the framework contributes to higher productivity and streamlined project workflows. Unlike more complex and costly solutions, this system presents a user-friendly, cost-effective alternative suitable for a wide range of construction projects. Moreover, the use of APIs lays the groundwork for future improvements, including AI-based document classification, intelligent search features using NLP, and broader integration with construction management tools. These enhancements promise to further optimize project timelines, reduce delays, improve communication, and establish a robust and systematic approach to construction documentation.

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