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Digital Transformation and Cybersecurity in Professional Practice: An Action Research Study of Secure Workflow Implementation in Natural Stone Project Delivery

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Abstract

This study examined how a secure digital workflow could support coordination efficiency, document-use accuracy, and workflow-level data protection across the natural stone project lifecycle within a professional practice context. It addressed workflow fragmentation in which project documents were managed through email correspondence, shared folders, and individually maintained records. These arrangements created recurring risks relating to version control, approval traceability, information retrieval, and access boundaries.

A practitioner-led Action Research approach was used to design, implement, and evaluate a purpose-built secure digital workflow within one live natural stone project. The intervention was organized through eight workflow stages and involved four direct operational system-user roles: Project Manager (PM), Engineering Team, Site Team, and Shipping Control. The workflow incorporated PM-controlled promotion of authoritative drawing batches, structured batch-status management, role-based access permissions, controlled external document release, and role-coded, timestamped workflow records.

Baseline evidence was retrospectively documented from recurring professional-practice patterns in the organization. Post-intervention evidence was generated prospectively during the intervention project from 2 February 2025 to 27 February 2026 through structured practitioner observation, workflow records, document and batch histories, categorical indicators, and descriptive system metrics.

Within the intervention project, all four predefined indicators recorded more favorable post-intervention conditions. Clarity of the Latest Approved Version shifted from LOW to HIGH. Frequency of Document-Related Errors arising from uncontrolled version circulation shifted from RECURRING to NONE OBSERVED. Ease of Tracking Approvals and Revisions shifted from LOW to HIGH. Information Governance and Data Protection Control also shifted from LOW to HIGH. Observation and system records indicated reduced reliance on manual document searching and repeated status confirmation, more consistent use of authoritative project information, and maintained role-based access and controlled external-release boundaries.

The findings indicate that improvements in coordination efficiency, document-use accuracy, approval traceability, and workflow-level data protection were associated with structured workflow governance, disciplined version control, authoritative batch promotion, and role-based access rather than technological complexity alone. The study provides practice-based

evidence from a specialized project-delivery context and identifies governance principles that may inform comparable professional environments. Transfer beyond the studied organization and project requires contextual adaptation and further evaluation across additional projects and settings.

Keywords: action research, digital transformation, secure digital workflow, document governance, role-based access control, workflow-level cybersecurity, data protection, natural stone project delivery

Chapter 1: Introduction

1.1. Professional and Organizational Context

This research examines a professional practice delivering architectural and hardscape projects involving natural stone. The organization is a project-based professional firm that provides natural stone consultancy, design coordination, technical documentation, fabrication coordination, delivery oversight, and site verification. Its work includes reviewing architectural and engineering information, identifying the stone elements required for each project, preparing shop drawings, coordinating review and approval processes, managing fabrication with external manufacturers, and supporting delivery and inspection at project sites.

Natural stone projects are information-intensive and involve multiple internal and external stakeholders, including architects, consultants, clients, engineering personnel, manufacturers, logistics providers, project managers, and site teams. Each project requires coordination between design intent, technical detailing, material specifications, approval decisions, fabrication requirements, and site conditions. Accuracy and consistency are important because discrepancies in dimensions, finishes, quantities, or document status can lead to delays, material waste, re-fabrication, or disputes over responsibility and approval (Whyte & Lobo, 2010).

In this setting, shop drawings have an important operational role. They translate architectural and design information into documentation ready for fabrication that defines dimensions, material types, finishes, fixing methods, quantities, and installation requirements. These drawings usually pass through preparation, review, revision, and approval before release for fabrication. This process generates large amounts of digital information, including source drawings, engineering outputs, revision records, approval documentation, pricing information, fabrication references, shipping records, and site observations.

The organization also works with natural stone manufacturers in different countries, depending on material type, origin, and availability. Once the relevant shop drawings are approved, the authorized documentation is released for fabrication. The manufactured stone elements are then packaged, transported internationally, delivered to the project site, and inspected against the approved documentation. This distributed supply chain makes it necessary to have clear information ownership, reliable version control, traceable approvals, and secure document exchange (Rezgui et al., 2013).

The researcher is directly involved in these professional activities and holds operational responsibility for technical document coordination, approval management, controlled document exchange, and support of project delivery. This insider position gives direct access to the processes examined in the study, but it also requires reflection on the researcher's influence on the design, implementation, observation, and interpretation of the intervention.

1.2. Overview of the Pre-Intervention Workflow

Before the secure digital workflow was introduced, natural stone projects in the organization followed a mostly sequential process, beginning with the receipt of architectural and engineering information and ending with delivery inspection and site confirmation. Although the main operational stages were understood from professional experience, the workflow had developed gradually in response to individual project needs rather than through a formally defined and consistently governed digital process.

The workflow began when architectural drawings, engineering information, and related design references were received from architects, consultants, or clients. These documents were reviewed to identify the required natural stone elements, including material types, finishes, dimensions, quantities, and locations. The relevant information was then interpreted and translated into detailed shop drawings for review, coordination, and fabrication.

Once prepared, shop drawings were circulated among the relevant internal and external parties for review and approval. Depending on the project, this could involve consultants, clients, the Project Manager, engineering personnel, and site representatives. Comments, revision instructions, and approval decisions usually moved through email, attached files, meeting discussions, and shared storage locations. Each revision produced additional drawing files, often retained and circulated separately. As a result, identifying the latest approved version depended on manual checking, file naming, email review, and individual awareness rather than on a single governed operational reference.

After approval, shop drawings and related fabrication information were sent to the selected natural stone manufacturer, often located in another country depending on material origin and availability. Production was based on the documentation received, while later clarifications, design adjustments, and scope changes were managed through further file and message exchanges. Without a unified document-governance structure, revised drawings, approval

decisions, pricing changes, and manufacturing instructions were not always maintained within one traceable record.

Following fabrication, the stone elements were packaged, shipped, delivered to the project site, and inspected against the approved shop drawings and project requirements. Shipping records, packing references, fabrication information, site observations, and any discrepancies were communicated digitally, but through the available informal channels rather than through one controlled workflow.

Across the pre-intervention workflow, project information was created, revised, stored, and exchanged through multiple folders, devices, email threads, and communication platforms. Projects could still be delivered through sustained professional coordination, but the process depended heavily on manual searches, individual memory, informal confirmation, and personal responsibility for maintaining continuity between stages. The main limitation was not the absence of digital tools, but the absence of an integrated governance structure that defined how project information should be classified, revised, approved, accessed, retained, and released. This made the workflow increasingly vulnerable to version ambiguity, weak approval traceability, fragmented coordination, and uncontrolled information exposure as project complexity increased.

1.3. Identification of the Problem

Although projects were completed under the pre-intervention workflow, the researcher observed recurring problems across several stages of natural stone project delivery. These problems did not point to particular individuals. They reflected structural weaknesses in how project information was created, revised, approved, accessed, retained, and released across the organization.

One problem was version clarity. Shop drawings commonly moved through several stages of review and revision, producing multiple files that were stored and circulated through email, shared folders, and individually maintained records. Without a governed version-control mechanism, identifying the latest approved drawing depended on manual checking, file naming, email searches, and direct confirmation between team members. This created an ongoing risk that a superseded or non-final drawing could be treated as an operational reference. A representative prior-project incident involved fabrication proceeding on the basis

of a superseded drawing, with the dimensional mismatch identified only after delivery to the project site (see Appendix C.1, Indicator 1).

Another problem was document-use accuracy. Under the pre-intervention workflow, there was no consistently enforced rule requiring each document change to be entered as a new traceable version with a defined status and contextual explanation. Multiple versions could circulate at the same time without a clear supersession mechanism. The accuracy problem examined in this study was not the technical correctness of engineering calculations or drawing content, but the risk that incorrect, outdated, or insufficiently controlled documentation could be used during coordination, fabrication, or site activities.

Approval and revision traceability was another weakness. Approval decisions, revision instructions, and scope changes were often communicated through verbal discussions, meetings, or dispersed email exchanges. No consistently structured approval record linked the responsible party, decision date, and approved document version within one accessible workflow. This made retrospective verification difficult and weakened the organization's ability to resolve disputes. A representative prior-project incident involved a client later disputing approval of a selected stone profile because no formal record was available to demonstrate the decision and its relationship to the relevant drawing and pricing documentation (see Appendix C.1, Indicator 3).

Information governance and data protection also raised concerns. Architectural drawings, shop drawings, pricing information, client details, and related project records were exchanged among internal and external parties without consistently defined access boundaries. Recurring baseline patterns included disclosure of client identity and property information beyond the intended operational scope, inadvertent transmission of internal supplier pricing to clients, and circulation of architectural documentation to external manufacturing parties. The most serious representative incident involved full architectural drawings being sent to a manufacturer in breach of a signed Non-Disclosure Agreement (see Appendix C.1, Indicator 4). These events showed that information exposure resulted from weaknesses in document segregation, access governance, and external-release control rather than isolated individual misconduct.

The fragmented workflow also increased coordination burden. Project personnel frequently had to search across multiple locations, confirm document status manually, reconstruct approval histories, and clarify which information should be used at a particular stage. Although the study did not measure task duration, labor productivity, or total project-delay reduction

quantitatively, these recurring practices created observable inefficiency and could delay approvals, fabrication decisions, and downstream coordination.

Taken together, these problems showed that the pre-intervention workflow lacked an integrated governance structure capable of maintaining a clear authoritative document reference, traceable approvals, controlled information access, and disciplined external release. The research problem was defined around four interrelated operational conditions: limited clarity of the latest approved version, recurring document-related errors arising from uncontrolled version circulation, weak approval and revision traceability, and insufficient information governance and data protection control. These conditions provided the basis for the four predefined indicators used to evaluate the workflow intervention (see Appendices C.1 and C.2).

1.4. Impact of the Problem on Professional Practice

The structural weaknesses in the pre-intervention workflow had direct consequences for professional practice in the organization. Their effects were evident in coordination effort, reliability of document use, decision traceability, protection of sensitive information, and the organization's ability to demonstrate controlled project delivery.

From an efficiency perspective, fragmented document storage and dispersed communication increased the effort required to progress work. Project personnel frequently had to search across email threads and shared folders, confirm which drawing represented the current approved reference, reconcile comments received through different channels, and reconstruct the status of outstanding decisions. These activities interrupted normal workflow progression and increased dependence on repeated clarification between roles. Although the study did not directly measure labor hours, task duration, productivity, or total project-delay reduction, the recurring need for manual searching and confirmation represented an observable coordination burden.

Document-use accuracy was also affected. Where multiple drawing versions circulated without a governed supersession mechanism, the risk of using an outdated or non-final drawing increased. The representative baseline incident involving fabrication from a superseded drawing showed the practical consequence of this weakness. The issue was not a technical engineering miscalculation, but a failure to maintain a clear and controlled operational reference throughout the document lifecycle. This created a risk of rework, corrective action, additional transportation, and avoidable disruption to project delivery.

Weak approval and revision traceability created further professional consequences. Where decisions were communicated verbally or retained across dispersed email exchanges, it could be difficult to establish who approved a change, when the decision was made, and which drawing or pricing record reflected that approval. This weakened accountability, complicated dispute resolution, and reduced the organization's ability to show that project actions were aligned with documented decisions.

Information governance weaknesses also exposed the organization to confidentiality and data-protection risk. Architectural drawings, client information, supplier pricing, and project documentation were exchanged across internal and external boundaries without consistently defined access and release controls. Prior incidents involving uncontrolled disclosure of client information, supplier pricing, and architectural documentation showed that these risks were embedded in the workflow structure rather than arising solely from isolated individual actions.

The combined effect of these conditions also had implications for professional credibility. Fabrication based on superseded information, unresolved approval disputes, and uncontrolled disclosure of sensitive material could affect confidence among clients, consultants, manufacturers, and other project stakeholders. The study did not measure reputational loss, future business opportunities, or commercial performance. Nevertheless, the identified incidents showed that weak workflow governance could compromise the organization's ability to present its project delivery processes as reliable, accountable, and appropriately controlled.

Addressing these weaknesses was both an operational and professional-practice requirement. A more structured workflow was needed to support clearer coordination, more reliable document use, stronger approval accountability, improved information governance, and greater confidence in the organization's management of complex project information.

1.5. Rationale for Digital Transformation

The problems identified in the pre-intervention workflow established a clear need for a more structured approach to digital transformation in the organization. Project delivery already relied on digital files, email, shared folders, and electronic communication. The main limitation was not the absence of technology, but the absence of an integrated governance framework that defined how project information should be created, classified, revised, approved, accessed, retained, and released (Vial, 2019).

For this professional setting, digital transformation offered an opportunity to move from fragmented digital practices toward a structured workflow in which information could be managed consistently across the project lifecycle. A governed digital environment could provide a main reference point for project documentation, clarify the relationships between workflow stages, and reduce dependence on manual searching, individual memory, and repeated confirmation of document status. The intended improvement concerned not only where files were stored, but also the rules governing their operational use.

A digitally defined workflow could support coordination by establishing explicit stages for project initiation, engineering submission, drawing review, pricing control, client revision, site verification, approval, manufacturing release, and shipping activity. Defining these stages, together with responsible roles and access boundaries, could help project personnel understand what action was required, which information was authoritative, and how each activity related to later project decisions (Chen et al., 2025). The anticipated efficiency benefit was reduced coordination overhead rather than a predetermined or quantified reduction in project duration.

Document-use accuracy provided a further rationale for the intervention. Structured batch creation, version identifiers, issue dates, contextual notes, status classification, and PM-controlled promotion of authoritative drawings could reduce the likelihood that outdated or non-final documents would be used as operational references. This approach was not designed to replace professional engineering judgment or verify the technical correctness of drawing content. Its purpose was to strengthen control over which project information was current, approved, traceable, and appropriate for use at a given workflow stage.

Digital transformation was also needed to strengthen information governance and data protection. The baseline workflow depended heavily on individual judgment when deciding what information could be accessed or transmitted. A role-based workflow could embed access boundaries into normal operations by separating operational project information from project owner information, detailed pricing documentation, contractual records, engineering submissions, approved drawings, fabrication records, and shipping information according to professional responsibility. Controlled external release could also ensure that manufacturers received approved shop drawings rather than unrestricted access to original architectural or commercially sensitive documentation.

The intervention did not assume that greater technological complexity would necessarily produce better outcomes. Shared storage could centralize files but would not, by itself, establish

authoritative batch promotion, role-based access, approval traceability, or controlled release (Whyte & Lobo, 2010). Conversely, a large enterprise platform could introduce functions and administrative requirements beyond the needs of this bounded professional context (Garzoni et al., 2020; OECD, 2021). A purpose-built web-based workflow was selected as a contextually aligned intervention through which the identified governance requirements could be implemented and evaluated in practice. This design decision reflected the organization's operational needs and was not designed to claim that a custom-built system is universally preferable to commercial or enterprise alternatives.

This study framed digital transformation as an organizational and governance intervention enabled by technology (Matt et al., 2015; Bharadwaj et al., 2013). The intervention was designed to evaluate whether clearer workflow stages, disciplined document control, traceable decisions, role-appropriate access, and controlled external release could support observable improvements in efficiency, document-use accuracy, approval traceability, and data protection in one live natural stone project.

1.6. Rationale for Cybersecurity

Natural stone project delivery requires the continuous exchange of commercially, contractually, and professionally sensitive digital information among internal and external stakeholders. This information may include architectural drawings, shop drawings, technical specifications, material and fabrication records, pricing documentation, client details, approval records, shipping information, and site observations. These records are essential to project delivery and may also contain intellectual property, confidential commercial information, and data protected by contractual obligations.

Within the pre-intervention workflow, project information was exchanged through email, shared cloud folders, individual devices, and other communication channels without consistently defined access boundaries. Access and distribution decisions depended heavily on individual judgment and immediate operational convenience. This made it difficult to distinguish consistently between information required for internal coordination, information appropriate for specific professional roles, and documentation authorized for external release. Established security-control catalogs, such as NIST SP 800-53, treat access control and accountability as core areas of organizational protection (Joint Task Force, 2020).

The risks were not limited to deliberate unauthorized access. Baseline evidence showed recurring patterns of unintended information exposure, including client identity and property details being shared beyond their intended scope, internal supplier pricing being transmitted to clients, and architectural drawings being circulated to external manufacturing parties without adequate control. The most serious representative incident involved the release of full architectural documentation in breach of a signed Non-Disclosure Agreement (see Appendix C.1, Indicator 4). These incidents demonstrated the need for information-protection controls embedded in the workflow rather than reliance on individual awareness alone.

Collaboration with manufacturers and other external project parties increased the importance of controlled document release. External parties required sufficient technical information to perform their contractual responsibilities, but they did not require unrestricted access to all project documentation. A governed workflow was needed to distinguish original design inputs from organization-prepared shop drawings, restrict project owner information, sensitive pricing, and contractual records according to role, and ensure that fabrication documentation was released only after the relevant drawing package had been reviewed and promoted as the authoritative approved reference (European Union Agency for Cybersecurity [ENISA], 2021).

Data integrity and accountability formed a further cybersecurity concern. Where multiple document versions circulated without clear status, date, contextual note, or approval record, it became difficult to establish which information was current and formally authorized. In this context, integrity involved maintaining confidence that operational decisions and external releases were based on appropriate approved documentation. Traceability involved retaining role-coded and timestamped records showing how submissions, revisions, approvals, and releases progressed through the project lifecycle.

Cybersecurity in this study was addressed primarily at the workflow and information-governance level. It concerned confidentiality through role-appropriate access, document integrity through controlled version and batch management, and accountability through traceable approval and activity records (Von Solms & Van Niekerk, 2013). The study did not constitute a comprehensive technical assessment of network security, encryption, authentication strength, malware protection, vulnerability management, or the security architecture of external organizations (Mantha & García de Soto, 2021).

Cybersecurity formed an integral component of the intervention rather than a separate technical objective. The secure digital workflow was designed to integrate information protection into

normal project activity through role-based permissions, PM-controlled authoritative drawing promotion, restricted management of sensitive pricing and client information, and controlled release of approved shop drawings to external manufacturing parties.

1.7. Research Aim, Research Question, and Objectives

The aim of this research was to design, implement, and evaluate a secure digital workflow intended to improve professional practice across the natural stone project lifecycle. The study addressed recurring operational challenges concerning coordination efficiency, document-use accuracy, approval traceability, information governance, and data protection within a real organizational setting.

The research was positioned as a practitioner-led Action Research study focused on improving an existing professional workflow through a context-specific intervention. It examined a retrospectively documented organizational baseline, implemented the secure workflow in one live natural stone project, and evaluated the changes through practitioner observation, system-generated records, project documentation, structured categorical indicators, and descriptive numerical system metrics.

The study was guided by the following research question:

How can a secure digital workflow improve efficiency, accuracy, and data protection across the natural stone project lifecycle within a professional practice context?

The study pursued the following research objectives:

1. To design and implement a secure digital workflow for natural stone project delivery, with a focus on fragmented workflows, inconsistent versions, and weak control of project documentation.
2. To evaluate how the secure digital workflow affected efficiency, accuracy, and data protection across the natural stone project delivery process within the professional practice context.
3. To analyze the findings of the secure digital workflow intervention and identify professional learning, methodological insights, and recommendations for practice in digital transformation and cybersecurity for project environments.

The research question and objectives provided the structure for the intervention, evaluation, and professional-learning analysis. Within the research question and the second objective,

accuracy refers primarily to the accurate use and control of project documentation, including version clarity and traceability, rather than to the technical correctness of engineering calculations or drawing content. Data protection refers to workflow-level controls concerning role-appropriate access, information segregation, document integrity, and controlled external release.

The research question was addressed through one bounded Action Research cycle involving planning, action, observation, and reflection in the intervention project. This structure allowed the study to investigate an established professional problem, apply a practical response, evaluate observable changes, and derive contextually grounded implications for future professional practice.

1.8. Justification for Using Action Research

Action Research was chosen as the method because the study was concerned with investigating and improving professional practice within the organizational setting where the identified problem occurred. The research addressed recurring weaknesses in document governance, workflow coordination, approval traceability, and information protection through the design and implementation of a practical intervention, rather than through detached observation alone (Reason & Bradbury, 2008).

This approach was well suited because the researcher was an insider practitioner with direct responsibility for project coordination, document control, approval management, and workflow improvement. This position provided sustained access to the organizational processes under investigation and enabled the intervention to be designed around actual operational requirements. It also allowed changes to be observed during normal project delivery. At the same time, the insider role required systematic reflexivity because the researcher contributed to the design, implementation, reinforcement, observation, and interpretation of the workflow intervention (Coghlan & Brannick, 2014).

The applied research question also supported the use of Action Research. The study did not seek only to describe the limitations of the pre-intervention workflow or test an abstract proposition separately from practice. It sought to design, implement, and evaluate a secure digital workflow designed to improve efficiency, document-use accuracy, approval traceability, and data protection in one live natural stone project. Action Research provided a structured

relationship between problem identification, intervention, observation, analysis, and professional learning.

The study implemented one bounded Action Research cycle involving planning, action, observation, and reflection (Kemmis et al., 2014). During planning, the workflow stages, role responsibilities, access boundaries, and document-control rules were defined. During action, the purpose-built workflow was introduced and used by four operational roles: Project Manager, Engineering Team, Site Team, and Shipping Control. Observation examined workflow activity through practitioner observation, system-generated records, project documentation, structured categorical indicators, and descriptive numerical metrics. Reflection considered implementation challenges, role-specific adoption patterns, professional learning, and implications for future practice.

Although Action Research is often carried out through several successive cycles, this study did not claim to have completed multiple independent cycles. Minor procedural adjustments, orientation reinforcement, and the introduction of a workflow handbook were used as refinements within the single intervention cycle because the core workflow structure and evaluation framework remained unchanged (Hammersley, 2004).

The four operational roles participated through their normal use of the workflow and the role-coded activity generated during project delivery. They were not positioned as co-researchers and did not jointly design the research methodology. The intervention was primarily practitioner-led, although later reflection identified earlier and more structured involvement of operational roles in workflow design as an improvement for future implementation.

Reflection was important because the study was concerned with system operation and professional learning. The structured reflective practice record documented the researcher's decisions, interpretations, challenges, and developing understanding across the cycle. However, reflective interpretation was distinguished from system-generated evidence and was not used as independent verification of participant perceptions or technical performance.

Action Research was also appropriate to the professional doctorate context because it connected systematic academic inquiry with organizational improvement (Costley et al., 2010). Its contribution lies in the documented improvement of professional practice in the intervention project and in the governance principles that may inform further evaluation in comparable project-based settings.

Chapter 2: Literature Review

2.1. Introduction to the Literature Review

This chapter sets out the academic and conceptual foundation for the study. It reviews literature on digital transformation, workflow and document governance, cybersecurity, Action Research, and small professional practice contexts. These areas are reviewed together because the research problem is not just technological. It concerns how project information is created, revised, approved, accessed, protected, and released within a professional workflow.

The literature is drawn from information systems, organizational studies, project-based work, cybersecurity, research on small and medium-sized enterprises (SMEs), and practice-oriented inquiry. These fields often examine related problems from different perspectives. Digital-transformation literature explains how technology can reshape organizational processes. Workflow and document-control literature explains how project information becomes reliable and authoritative. Cybersecurity literature explains how confidentiality, integrity, access, and accountability are governed. Action Research literature explains how professional practice can be examined through planned intervention and reflection. SME literature explains why digital and security controls must remain proportionate to organizational scale and capability.

The review is organized thematically rather than as a sequence of individual studies (Webster & Watson, 2002; Snyder, 2019). Its purpose is to synthesize the concepts most relevant to the research question and to identify where existing literature provides only partial explanations of the problem examined in this study. The chapter focuses on organizational implementation, workflow governance, role-based access, information integrity, approval traceability, and secure professional practice. Literature concerned only with technical system architecture, software engineering, or infrastructure security is included only where it contributes directly to these concerns.

The chapter remains separate from the empirical contribution of the study. The intervention design, project evidence, system records, indicator results, and reflective findings are addressed in later chapters. The distinction matters because Chapter 2 establishes the conceptual basis for the research, while later chapters examine how the secure digital workflow operated in the specific professional context.

The review is structured around five themes. The first examines digital transformation in professional practice. The second considers workflow management and document control. The

third addresses cybersecurity and data protection in organizational workflows. The fourth reviews Action Research as a methodology for practice-based inquiry. The fifth examines SMEs and smaller professional firms as contexts for digital and secure workflow implementation. The concluding synthesis integrates these themes and identifies the conceptual gap addressed by the study.

2.2. Theme 1: Digital Transformation in Professional Practice

Digital transformation is widely discussed in information systems, management, and organizational literature, but it should not be reduced to the adoption of digital tools. A professional organization may use email, cloud folders, shared files, and electronic communication while still relying on fragmented responsibilities, informal approvals, unclear document status, and weak information governance. In that situation, the organization is digitally equipped, but its operating model has not necessarily been transformed (Legner et al., 2017).

For this study, digital transformation is understood as a deliberate organizational process through which digital means are used to redesign professional workflow, information governance, and decision accountability. This understanding reflects the wider literature, which treats digital transformation as a change in organizational processes, structures, capabilities, roles, and value creation rather than as simple digitization or automation (Vial, 2019; Bharadwaj et al., 2013; Matt et al., 2015).

The distinction between digitization, digitalization, and digital transformation is important. Digitization refers mainly to converting analog material into digital form. Digitalization refers to using digital tools to support or improve existing activities. Digital transformation goes further because it changes how work is organized, governed, evaluated, and connected to organizational purpose (Verhoef et al., 2021). This distinction is relevant to the present study because the problem was not the absence of digital files or electronic communication. The problem was the absence of a governed workflow defining document authority, version status, approval responsibility, role-based access, and controlled release.

Digital transformation also requires strategic and managerial alignment. Digital tools create value when they are connected to changes in operating processes, governance, leadership, and organizational coordination. Where technology is introduced without changes to responsibility, authority, and decision structure, it may reproduce the same fragmentation in a new digital

environment (Hanelt et al., 2021). This matters in professional project environments, where work depends on sequential decisions, distributed expertise, temporary relationships, and large document sets.

Project-based digital transformation has additional complexity because projects are not stable routine operations. They bring together multiple roles, organizations, and specialist knowledge for a defined period. Their information requirements change during design, review, approval, fabrication, delivery, and site verification. In such settings, digital transformation depends on the relationship between tools, project methods, governance, organizational structure, leadership, and sector-specific working practices (Whyte, 2019). This supports the view that transformation in this study should be examined as a socio-technical and organizational change, not as a technology installation (Sarker et al., 2019).

Several drivers explain why professional organizations pursue digital transformation. Fragmented workflows can increase manual searching, duplicated handling, repeated clarification, and uncertainty about which information is current. In document-intensive work, this creates risks for coordination, approval traceability, and operational reliability. Digital transformation can respond to these pressures by improving information visibility, clarifying workflow stages, and creating more consistent access to current records. However, these benefits depend on governance rules for classification, revision, approval, access, and retention, not on centralization alone (Vial, 2019).

Strategic, environmental, and stakeholder pressures also influence transformation. Clients, consultants, suppliers, and external parties increasingly expect timely communication, accessible records, and transparent decision processes. Regulatory, contractual, competitive, and supply-chain conditions can also increase the need for documented accountability and information protection. In project-based environments, these pressures are intensified because outputs often depend on sequential approvals and coordination across interdependent activities. Construction-sector literature similarly shows that technological readiness, organizational capability, and environmental pressures influence digital-technology adoption and that outcomes vary across project contexts (Oesterreich & Teuteberg, 2016).

Risk reduction is another important driver. Where professional decisions depend on drawings, approvals, technical records, pricing information, or external manufacturing instructions, weak information control can create operational, contractual, commercial, or reputational consequences. Digital transformation may be justified not just as a way to improve efficiency,

but also as a way to reduce ambiguity, strengthen traceability, and establish clearer accountability.

The literature also shows that digital transformation is often constrained by organizational and socio-technical barriers. Existing routines, tacit knowledge, informal coordination, and professional discretion may be deeply embedded in daily practice. A new system that increases visibility, changes responsibilities, or requires more structured documentation may be experienced as disruption rather than improvement. Resistance should not automatically be treated as opposition to technology. It may indicate unclear purpose, poor process fit, insufficient training, excessive complexity, or a mismatch between the formal workflow and actual professional practice (Lapointe & Rivard, 2005).

Strategic ambiguity can further weaken implementation. If a digital initiative is presented as a technical project without a clear relationship to organizational priorities, users may treat it as temporary or peripheral. Digital transformation requires alignment between technology, organizational structure, value creation, and leadership practice (Bharadwaj et al., 2013; Matt et al., 2015; Westerman et al., 2014). Without this alignment, an organization may adopt new tools while retaining the behaviors and informal processes that produced the original problem.

Capability and usability also affect adoption. Professional roles differ in their exposure to digital systems, their responsibilities, and the time available for learning. Training must be linked to actual role-based tasks rather than delivered as generic awareness (Legner et al., 2017; Hanelt et al., 2021). Similarly, a workflow that adds unnecessary steps or fails to reflect operational priorities may encourage workarounds. In project-based settings, time pressure and temporary team structures can intensify these barriers because users may be expected to learn and apply new systems while active project delivery continues (Chen et al., 2025; Qadir et al., 2026).

The potential value of digital transformation is conditional. Digital workflows may improve access to information, strengthen coordination, support version consistency, improve approval traceability, and create clearer accountability. These outcomes are especially relevant where professional work depends on technical, contractual, commercial, and project documentation. However, digital records are not inherently reliable. Their value depends on disciplined use, complete records, defined document states, and clear responsibility for approval and release.

The literature does not support a deterministic assumption that technology automatically improves performance. Digital initiatives may create new dependencies, administrative

burdens, integration challenges, or overly rigid controls if they are not aligned with professional work. Standardization can improve consistency, but excessive rigidity may reduce adaptability. In project-based environments, local improvement in one project should also be distinguished from sustained organizational transformation across projects (Whyte, 2019; Hanelt et al., 2021). Reported benefits must be interpreted in relation to the setting, evidence base, implementation conditions, and measurement approach (Matt et al., 2015; Chen et al., 2025; Qadir et al., 2026).

For the professional context of this study, the literature supports a focused interpretation of digital transformation. The issue is not whether digital technology is beneficial in general, but how digital means can be used to create a governed workflow that clarifies document authority, role responsibility, approval status, information access, and external release. This matters in specialized natural stone project delivery, where work involves design interpretation, iterative shop-drawing development, approval control, international fabrication, shipping coordination, site verification, and the exchange of commercially and contractually sensitive documentation (Whyte, 2019; Oesterreich & Teuteberg, 2016).

Existing literature gives useful principles concerning digital transformation, strategic alignment, project-based adoption, governance, and socio-technical implementation. However, it provides limited direct examination of secure digital workflow transformation in specialized natural stone professional practice. This gap supports the need for a context-specific investigation of how digital-transformation principles can be integrated into actual project activity through workflow governance, document control, role-based access, traceability, and information protection.

2.3. Theme 2: Workflow Management and Document Control

Project-based workflows differ from routine operational processes because they are temporary, multi-organizational, and directed toward defined deliverables. They bring together participants from different professional disciplines, contractual relationships, and organizational systems, often for a limited period. Coordination depends not just on completing individual tasks, but also on managing the interfaces between roles, work packages, information categories, and decision points (Whyte, 2019).

This characteristic is important to document-intensive project work. Digital drawings, specifications, approval records, technical documents, pricing information, fabrication

references, shipping records, and site observations do not simply describe a project. They enable and authorize professional action. In project environments, documents function as coordinating objects through which knowledge is exchanged, responsibilities are exercised, and work is controlled across organizational boundaries (Carlile, 2002; Whyte & Lobo, 2010).

Fragmentation is a defining feature of project-based workflow. Information is produced and used by participants with different responsibilities, priorities, and levels of authority. Construction and civil-engineering environments are commonly characterized by data-intensive activity, multiple professions, extended supply chains, and distributed responsibility (Rezgui et al., 2013). These conditions create multiple handover points. Information produced by one role may be required before another activity can begin, while a change in one part of the project may affect several downstream decisions. Where these dependencies are not clearly governed, participants may rely on informal communication, personal knowledge, repeated clarification, or local file practices to maintain continuity.

Document control is a governance function rather than a purely administrative activity. International standards for information management in construction treat each document as an information container that carries a defined state and a status code showing its permitted use (International Organization for Standardization [ISO], 2018). Project documentation changes over time as designs are revised, comments are incorporated, scope decisions are made, and approvals alter the operational status of information. A document may begin as a working submission, pass through review and revision, become an approved reference, and later remain as a historical record after another version is authorized. The main workflow issue is not only where a document is stored, but how its status, authority, history, and permitted use are defined.

Version control supports this governance function by distinguishing working, revised, approved, superseded, and historical records. Without a structured method for identifying document development, several versions may remain available without a clear indication of which one governs current work. This ambiguity is especially significant where documents move between organizations or are used for fabrication, delivery, or site verification. A controlled versioning process should make visible when a version was created, who submitted it, the date of issue, the purpose or context of change, its current status, and its relationship to previous versions. Historical retention can support auditability, but historical availability must be clearly separated from current operational authority (Whyte et al., 2016).

Approval cycles provide the decision structure through which a working document becomes an authorized reference. In project-based environments, approval may involve repeated review, revision, and confirmation by different parties. Where approval decisions are dispersed across meetings, email correspondence, verbal discussions, or separate storage locations, it becomes difficult to establish which comments were incorporated, who authorized the final decision, and which version was approved. A governed approval process should connect the responsible role, relevant document version, decision date, and resulting status (ISO, 2018; Whyte et al., 2016). This creates a defensible relationship between project action and approved information.

Digital repositories and workflow platforms can support document control by centralizing records, preserving histories, improving visibility, and structuring transitions between document states. A major infrastructure project studied by Whyte and Lobo showed that a project extranet and standardized forms improved access to approved drawings, preserved an archive, and supported workflow management, knowledge approval, and accountability. However, the value of the repository depended on its relationship with project practices and standardized procedures, not on storage capability alone (Whyte & Lobo, 2010).

The distinction matters because technology does not establish authority automatically. A shared digital environment may contain many files without making clear which document is current, approved, restricted, retained, or released (ISO, 2018). Governance defines how a workflow tool should be used: who may create or upload information, who may review or modify it, who has authority to approve it, who may access current or historical records, and what conditions must be met before information moves to another workflow stage. Process controls translate these rules into operational mechanisms such as document-status classifications, approval checkpoints, version histories, permission structures, contextual notes, and recorded transitions.

Access control is part of this workflow-governance structure. Different roles do not require identical access or authority. One role may prepare information, another may review it, another may approve it, and another may depend on the approved output for fabrication, delivery, or site activity. Role-based access is not just a technical security setting; it is an organizational decision about responsibility, confidentiality, and authority (Rezgui et al., 2013).

Existing literature also shows limitations in digital workflow approaches. Centralized storage does not necessarily produce fully integrated working. Some live design activity may continue outside the formal repository, and distributed teams may still become misaligned when

exchanging models or working information (Whyte & Lobo, 2010). Formal and informal systems may coexist, with final documents stored in a repository while working files continue to move through email, local folders, or other platforms (Alter, 2014). The presence of a repository should not be treated as evidence that all project information is controlled through one authoritative workflow.

Further limitations arise from interoperability, mixed formats, legal responsibilities, intellectual-property concerns, and differences in organizational maturity across project participants. Information may exist as paper records, conventional digital files, object-based models, or records within specialist systems, while participants may have different rights and responsibilities for creating, modifying, owning, and releasing information. These conditions require governance beyond purely technical integration (Rezgui et al., 2013).

Mobile and cloud-based document-management tools can increase accessibility and support field-based work. They may provide real-time access to project documents, collaboration functions, automated processes, and practical support for professionals away from fixed office environments. However, functional availability does not by itself resolve version ambiguity, approval authority, access governance, or sustained adoption. Reviews of mobile document-management applications demonstrate technological potential, but provide more limited evidence concerning long-term governance within live project settings (Whyte, 2019).

The literature distinguishes between digital availability and governed workflow operation. Storage makes information accessible; governance defines its authority, status, responsibility, access, and permitted use. An overly loose system may leave document authority dependent on personal interpretation, while an overly rigid system may encourage workarounds if it does not reflect professional practice (Alter, 2014). Effective workflow management must balance control with adaptability by providing enough structure to maintain clarity, accountability, and continuity without preventing legitimate professional judgment.

For this study, the relevance of this literature lies in its emphasis on document authority, version discipline, approval traceability, role-based access, and proportional process control. These issues are directly applicable to specialized natural stone project delivery, where architectural design inputs, shop-drawing production, repeated review and approval, international fabrication, shipping coordination, site verification, and commercially sensitive information must remain connected to documented decisions. Existing literature gives useful principles concerning repositories, digital coordination, lifecycle information governance, and document-

management tools. Formal standards provide a further reference point. ISO 19650 offers an internationally recognized model for information-container states, status codes, and authorized transitions between them (ISO, 2018). However, it is framed primarily for BIM-enabled, multi-party construction delivery, and it offers little guidance on proportionate implementation within small, specialized, non-BIM professional practices such as natural stone project delivery.

Taken together, this body of work offers limited direct analysis of how these principles can be implemented proportionately within a small, specialized natural stone professional practice. This gap supports the need for a context-specific workflow that combines document centralization with explicit version discipline, approval authority, role-based access, traceability, and controlled external release.

2.4. Theme 3: Cybersecurity and Data Protection in Organizational Contexts

Cybersecurity is increasingly relevant to professional workflows because project information is now created, reviewed, stored, exchanged, and retained through digital and distributed systems. Shared repositories, cloud services, web-based applications, and cross-organizational collaboration platforms can improve accessibility and coordination, but they also increase the number of users, systems, and organizational boundaries through which information passes (Von Solms & Van Niekerk, 2013).

In this context, cybersecurity should not be understood only as protection against deliberate cyberattacks. It also concerns the ordinary conditions under which information is accessed, modified, transferred, retained, and relied upon during professional activity. Confidentiality may be weakened when information is shared beyond its intended audience. Integrity may be affected when document status, authority, or revision history is unclear. Accountability may be reduced where actions and decisions cannot be traced to an authorized role. This broader understanding reflects the view that cybersecurity operates within an interconnected environment of information, technologies, people, and organizations rather than within isolated internal systems alone (Von Solms & Van Niekerk, 2013).

Distributed project workflows create particular security and governance challenges because external participants often require selected information without requiring access to the full project record. The relevant question is not simply whether access is technically possible, but whether it is proportionate to professional responsibility and limited to the information required

for an authorized task (Saltzer & Schroeder, 1975). This matters where project information moves between internal personnel, clients, consultants, suppliers, manufacturers, and site teams.

Supply-chain relationships further extend the security boundary. Organizations may be affected by suppliers or external parties whose controls, resources, or security maturity differ from their own. Although supply-chain cybersecurity literature often focuses on deliberate attacks, its wider implication is that an organization cannot manage information protection only within its formal internal boundary (ENISA, 2021). This is relevant to project-based professional work, where documents may be received, stored, reused, or transmitted by parties outside the originating organization's direct control.

Cybersecurity risks also change across the project lifecycle. At project initiation, sensitive information may include client details, property locations, contractual records, preliminary designs, and architectural documentation. During design and technical development, risk increases as multiple drawings, comments, revisions, and approvals are created. At this stage, integrity is closely connected to document governance: a failure may occur not because a document has been maliciously altered, but because an outdated, incomplete, or incorrectly authorized version is treated as current. During approval, commercial, production, shipping, and site stages, confidentiality and accountability become especially important because pricing information, approval records, fabrication instructions, delivery documents, and inspection records may require different levels of access and retention.

The architecture, engineering, and construction sector illustrates why lifecycle and sector-specific analysis matters. Cybersecurity research in this sector remains relatively limited despite increasing reliance on digital tools, connected stakeholders, and project data. Risks and consequences may differ across industries and project phases, which means that generic cybersecurity assumptions may not fully explain project-based professional environments (Mantha & García de Soto, 2021).

Access control, confidentiality, and integrity are important to secure workflow design. Access control determines which users or roles may view, upload, modify, approve, release, or retrieve information (Sandhu et al., 1996). In a professional workflow, access governance must reflect responsibility rather than simply granting or denying entry to a system. A Project Manager may require access to client, contractual, and commercial records; an Engineering Team may require technical inputs and submission functions; a Site Team may require current approved

information for verification; and an external manufacturer may require only authorized fabrication documentation (Sandhu et al., 1996; Saltzer & Schroeder, 1975).

Under the GDPR, confidentiality forms part of the principle of "integrity and confidentiality," which requires personal data to be processed securely and protected against unauthorized or unlawful processing (European Union, 2016, Art. 5(1)(f)). In distributed workflows, this risk may arise through ordinary working practices, such as attaching files to messages, placing documents in broadly accessible folders, or sending records externally without separating necessary content from restricted information. Integrity concerns confidence that information is accurate, complete, appropriately authorized, and protected from unauthorized change. In document-intensive work, integrity depends on the ability to distinguish authoritative records from drafts, superseded versions, or documents awaiting review. Version identifiers, dates, contextual notes, status classifications, and approval records support information integrity by making authority and document history visible.

These controls are consistent with established security-control thinking, which treats access control, audit and accountability, awareness and training, system and information integrity, and supply-chain risk management as interconnected areas of organizational protection (Joint Task Force, 2020). However, in this study these principles are applied at the workflow and information-governance level rather than as a comprehensive technical cybersecurity audit.

Traceability complements access, confidentiality, and integrity by recording who performed an action, when it occurred, and which information was affected. Traceability does not prove that every decision is correct, but it supports accountability and allows the sequence of actions to be reconstructed when clarification or investigation is required. Secure workflow design requires a balance between protection and usability. The objective is not to prevent information exchange, but to ensure that information is accessed, modified, approved, and released according to defined professional responsibilities and documented workflow conditions.

Human behavior is also important to cybersecurity, but it should not be reduced to individual carelessness. User behavior is shaped by system usability, workload, organizational culture, role clarity, training, leadership consistency, and the perceived relevance of security procedures (Adams & Sasse, 1999). Controls that are poorly aligned with work may encourage avoidance or informal workarounds even where users recognize the importance of protecting information (Alter, 2014; Adams & Sasse, 1999). Cybersecurity governance should be integrated into

business processes and organizational practice rather than treated as isolated technical settings (Metin et al., 2024).

Training and awareness remain important, but generic security awareness may be insufficient for professional workflows. Guidance should be linked to actual tasks such as handling restricted documents, selecting appropriate recipients, distinguishing approved information from drafts, and managing external release. Users are more likely to apply controls consistently where they understand what information they are responsible for, what actions they are authorized to perform, why certain information is restricted, and what consequences may follow from bypassing the governed workflow.

Organizational culture and leadership reinforce these expectations. Where managers continue to use informal channels while formally requiring system compliance, users receive conflicting signals. Conversely, consistent use of the governed process shows that information protection is part of normal professional practice rather than an additional administrative burden. Usability is not separate from security; it is one of the conditions that makes secure behavior practical (Adams & Sasse, 1999).

Small and medium-sized enterprises face further constraints. Limited budgets, small teams, overlapping responsibilities, reduced specialist expertise, and dependence on external providers can affect the selection and maintenance of cybersecurity controls. Broad information-security standards may be difficult for SMEs to interpret and implement without specialist knowledge, which supports the need for scalable approaches connected to actual risks, business processes, and organizational capability (International Organization for Standardization & International Electrotechnical Commission [ISO/IEC], 2022; Metin et al., 2024). Resource limitation does not remove security responsibility, but it affects the form that protection can realistically take.

For project-based SMEs, effective cybersecurity is likely to depend less on technological scale than on clarity and consistency. A limited set of well-defined workflow rules, access permissions, approval responsibilities, account controls, traceable records, and external-release procedures may be more sustainable than a complex framework that cannot be maintained in routine practice. This matters where one person may perform overlapping operational, managerial, commercial, and administrative functions, making strict separation of duties difficult but documentation of authority more important.

For the professional context of this study, the literature supports a workflow-level interpretation of cybersecurity and data protection. Natural stone project delivery involves architectural and shop-drawing information, client and pricing records, iterative approvals, international manufacturers, fabrication tracking, shipping coordination, and site verification. Different parties require different information at different stages, while inappropriate disclosure or unreliable documentation may create operational, commercial, contractual, or reputational consequences (European Union, 2016, Art. 25).

Data protection also carries a formal regulatory dimension. The General Data Protection Regulation requires that protective measures be embedded in the design of processing activities rather than added afterwards, and that personal data be limited to what is necessary for the purpose (European Union, 2016, Arts. 5 and 25). This principle of data protection by design aligns closely with a workflow-level approach in which access boundaries, information segregation, and controlled release are built into routine project activity. Yet the Regulation states an obligation rather than an operational model. It does not specify how a small, project-based professional practice should structure document authority, role permissions, or external-release decisions in everyday delivery.

Taken together, the academic literature, the established control frameworks, and the regulatory requirements each contribute part of the picture. The literature provides general principles concerning cybersecurity governance, access control, data integrity, human factors, SME constraints, and supply-chain exposure. Control frameworks such as NIST SP 800-53 and ISO/IEC 27001 specify what should be protected, while the GDPR specifies what must be achieved. Neither prescribes how these requirements should be enacted through the routine document handling, approval authority, and external-release decisions of a small specialist practice. The result is limited direct evidence on how these principles can be integrated into a proportionate secure workflow for specialized natural stone project delivery. This gap supports the study's focus on role-based access, controlled document authority, traceable actions, and restricted external release within the specific project context.

2.5. Theme 4: Action Research in Professional Doctorates

Action Research provides a relevant methodological foundation for studies that seek to investigate and improve professional practice at the same time. Its main feature is the integration of systematic inquiry with intentional action (Lewin, 1946). Rather than separating analysis from intervention, Action Research examines a real practice-based problem through

planned change, observation, and reflection. Professional improvement alone is not sufficient to constitute research; the action must be accompanied by evidence collection, critical interpretation, and a clear account of what has been learned (Reason & Bradbury, 2008; Susman & Evered, 1978).

This approach is appropriate where the research problem is embedded within an organizational setting and cannot be separated easily from the people, routines, responsibilities, and constraints that shape it. Professional doctorate research often addresses such problems because it aims to generate knowledge through the critical examination and development of practice. Work-based inquiry can be academically credible where it is supported by systematic design, transparent evidence, and critical reflection rather than by practitioner experience alone (Costley et al., 2010; Herr & Anderson, 2005).

Action Research should not be treated as one uniform methodology. It includes different traditions with different assumptions about participation, change, and knowledge. Critical participatory Action Research emphasizes collective inquiry into shared practices and may involve participants as co-researchers in defining concerns, shaping the inquiry, interpreting evidence, and taking action (Kemmis et al., 2014). However, organizational and practitioner-led forms of Action Research may be structured differently. Professional actors may participate through their use of an intervention and through the operational evidence generated by their work without sharing responsibility for the research design or formal analysis. The level of participation must be described accurately rather than assumed from the Action Research label.

Action Research is commonly represented through a cycle or spiral of planning, action, observation, and reflection. Planning defines the practice-based concern, the intended intervention, and the evidence required to examine it. Action introduces the intervention into the professional setting. Observation records what occurs during implementation. Reflection interprets the evidence, examines assumptions and decisions, and identifies implications for practice and further learning (Reason & Bradbury, 2008; Kemmis et al., 2014). These phases provide a disciplined logic of inquiry, but they should not be treated as a rigid sequence. Observation and reflection may occur during implementation, and minor adjustments may be made as learning develops.

The language of cycles requires particular care. Iteration does not mean that every refinement is a separate Action Research cycle. Clarifying instructions, reinforcing system use, improving orientation, or making minor procedural adjustments may occur within one bounded cycle

where the core intervention, objectives, and evaluation framework remain stable. Methodological credibility does not depend simply on claiming multiple cycles; it depends on whether the relationship between planning, action, observation, reflection, and learning is documented clearly. Transparent reporting of one complete cycle is stronger than claiming multiple cycles that cannot be demonstrated through evidence. On this view, the validity of an Action Research study rests on recoverability rather than repeatability: an independent reader should be able to trace how conclusions were reached, provided the intervention, the evidence sources, and the interpretive framework were declared in advance (Checkland & Holwell, 1998). A single bounded cycle reported transparently can therefore satisfy this criterion, whereas multiple cycles asserted without a recoverable evidence trail cannot.

Insider research is another main issue in organizational Action Research. In professional doctorate studies, the researcher is often an established member of the organization or profession being examined. This position can provide important advantages, including access to practice, understanding of workflow, awareness of informal routines, and the ability to design an intervention that is operationally realistic (Brannick & Coghlan, 2007). Insider inquiry can support a detailed and contextually informed account of organizational practice (Coghlan & Brannick, 2014; Costley et al., 2010).

At the same time, insider knowledge is not the same as research evidence. Familiarity with the organization may lead the researcher to take assumptions for granted, interpret events through existing loyalties, overlook alternative explanations, or prefer evidence that supports the perceived success of the intervention. Where the researcher also holds managerial or operational authority, users may adapt their behavior because the researcher is connected to performance expectations or project management (Brannick & Coghlan, 2007; Herr & Anderson, 2005). These risks do not invalidate insider research, but they must be acknowledged and managed through reflexivity.

Reflexivity is the process through which the researcher examines how their position, assumptions, authority, decisions, and professional interests influence the inquiry (Finlay, 2002; Alvesson & Sköldberg, 2018). It does not remove subjectivity or guarantee neutrality. Instead, it makes the researcher's influence visible by documenting key decisions, distinguishing contemporaneous observation from later interpretation, considering alternative explanations, and identifying where the researcher's role may have shaped implementation or interpretation. Reflexive documentation can provide an audit trail of professional judgment,

but it should not be confused with independent evidence of system performance or participant perception.

The strengths of Action Research are closely connected to its limitations. Its strength lies in its relevance to real professional problems, its responsiveness to organizational complexity, and its capacity to connect academic inquiry with practice-based learning. It allows contextual factors such as routines, resources, role relationships, and implementation pressures to be examined rather than treated as irrelevant background. However, because Action Research usually occurs in uncontrolled settings, it cannot normally support strong causal claims. Observed improvement may be associated with the intervention without proving that the intervention alone caused the change (Checkland & Holwell, 1998; Susman & Evered, 1978).

Further limitations concern researcher bias, transferability, and participation. The practitioner-researcher may design, promote, manage, observe, and evaluate the same intervention, creating a risk of selective attention or favorable interpretation. Findings from one organization or one project may also depend on local conditions and should not be presented as universally generalizable. Participation must be described in operational terms; users should not be called collaborators or co-researchers unless they were meaningfully involved in the research design, interpretation, or dissemination. Concerns about rigor in Action Research reinforce the need for clear objectives, contemporaneous records, multiple evidence sources where appropriate, explicit limitations, and proportional claims (Hammersley, 2004; Checkland & Holwell, 1998).

For this study, the literature supports positioning the research as practitioner-led organizational Action Research rather than critical participatory Action Research (Coghlan & Brannick, 2014; Herr & Anderson, 2005). The researcher held an insider professional role and retained primary responsibility for defining the research problem, designing the secure digital workflow, establishing the evaluation framework, and interpreting the evidence. Four operational roles were involved in the live workflow: Project Manager, Engineering Team, Site Team, and Shipping Control. Their role-coded activity and system use contributed empirical evidence, but they were not positioned as co-researchers and did not jointly determine the methodology or conduct the formal analysis.

The study comprised one bounded Action Research cycle organized around planning, action, observation, and reflection. Planning established the workflow structure, roles, access boundaries, and evaluation approach. Action involved implementing the workflow in one live natural stone project. Observation drew on system activity, project documentation, structured

practitioner observation, categorical indicators, and descriptive numerical metrics. Reflection examined the researcher's decisions, professional learning, implementation challenges, and role-specific adoption observations. Minor procedural adjustments and orientation reinforcement were used as refinements within the single cycle rather than as separate cycles.

This methodological position is appropriate because the study examines the secure digital workflow as both an organizational intervention and a source of professional learning. Its credibility depends on transparent reporting of the bounded cycle, researcher role, participant involvement, evidence sources, reflexive limitations, and the distinction between operational evidence and reflective interpretation.

2.6. Theme 5: SMEs and Professional Practice Contexts

2.6.1. Characteristics of SMEs and Project-Based Professional Firms

Small and medium-sized enterprises are not a single uniform organizational category. They differ by sector, ownership, capability, market position, and level of formalization. However, SME literature identifies recurring characteristics that influence how smaller firms organize work and approach digital change: limited specialist resources, concentrated managerial responsibility, close interaction between strategic and operational activity, and dependence on a small number of individuals (OECD, 2021).

These characteristics can support responsiveness. In smaller firms, fewer organizational layers may separate a problem from an authorized decision. This can allow rapid adjustment to client needs or project changes. At the same time, concentrated authority can create dependency on individual availability, experience, and judgment. Where key knowledge is held by a small number of people rather than embedded in documented processes, organizational continuity becomes more vulnerable.

Professional SMEs often combine managerial, technical, commercial, and coordination responsibilities within the same roles. This overlap may be appropriate to organizational scale, but it can limit separation of duties and make responsibility difficult to reconstruct where decisions remain informal. Smaller firms also rely heavily on experiential and tacit knowledge (Nonaka, 1994). Such knowledge supports flexibility and professional judgment, but it may not provide consistent records of document authority, approval responsibility, access boundaries, or retention requirements.

Project-based professional firms face additional complexity because their work is temporary, client-specific, and dependent on changing combinations of internal and external participants (Hobday, 2000). Each project may involve different consultants, suppliers, contractors, document structures, approval responsibilities, and communication channels. Complete standardization may be unrealistic, but the variability of project work increases the need for a stable governance framework that defines which controls must remain consistent across projects.

2.6.2. Digital Transformation Challenges in SMEs

Digital transformation in SMEs is constrained by access to technology and the organizational capacity required to select, integrate, govern, and sustain it. Smaller firms may be able to adopt digital tools, but transformation requires changes to responsibility, process ownership, staff learning, decision-making, and everyday working routines (Eller et al., 2020).

Financial and human-resource constraints are central. Enterprise platforms, consultancy, integration, migration, training, and continuing support may be difficult to justify against immediate project-delivery priorities. Employees in smaller firms may also perform several functions and have limited time to participate in redesign or training. As a result, digital transformation often has to occur alongside normal work rather than through a separately resourced program.

Successful SME digitalization depends on more than technology investment. Skills, digital strategy, organizational culture, and external support shape both adoption and outcomes (Eller et al., 2020). Similarly, SME digital transformation can be understood as a staged development from awareness to enquiry, collaboration, and deeper transformation, indicating that digital maturity involves organizational and relational change as well as technology acquisition (Garzoni et al., 2020).

Fragmented adoption is a common risk. A firm may introduce separate tools for communication, document storage, accounting, project tracking, or external collaboration without defining how information should move between them. This produces digital activity but may leave authority, ownership, workflow status, and version responsibility unresolved. Informal processes can further complicate implementation because existing practices may depend on personal communication, undocumented judgment, or knowledge held by specific individuals.

Resistance to digital change should not be read automatically as unwillingness to improve (Lapointe & Rivard, 2005). In SMEs, resistance may indicate poor process fit, insufficient explanation, inadequate training, or a system whose complexity exceeds organizational needs. External relationships can also reproduce fragmentation where clients, consultants, suppliers, or contractors require different platforms or communication channels. SMEs may have limited influence over these external arrangements while still needing to maintain reliable internal records.

2.6.3. Cybersecurity Challenges in SMEs

Cybersecurity challenges in SMEs are closely connected to the same organizational conditions that affect digital transformation. Limited budgets, small teams, overlapping responsibilities, and dependence on external providers can restrict the development of specialist security arrangements. Many SMEs do not employ dedicated cybersecurity personnel, and responsibility may be shared between senior management, operational staff, general IT support, and external providers. This may be workable, but accountability becomes unclear where responsibilities, escalation procedures, and decision authority are not documented.

Broad information-security standards can also be difficult for SMEs to interpret and operationalize without specialist expertise. SME cybersecurity governance requires scalable controls that correspond to actual risks, organizational capability, business processes, staff understanding, and resource constraints (ISO/IEC, 2022; Metin et al., 2024).

Cybersecurity awareness is important, but secure behavior should not be treated as an individual responsibility alone. Users need clear and usable procedures that explain what information is restricted, who may access it, how it may be shared, and which actions require approval. In smaller professional teams, informal trust may replace formal access governance, especially where immediate coordination is prioritized. However, trusted collaboration does not remove the need to distinguish between information that is operationally necessary and information that is commercially, personally, or contractually restricted.

Incremental technology adoption can create additional exposure. Project information may be dispersed across email accounts, local devices, shared folders, messaging applications, cloud services, and external systems. Where these tools are not governed as a connected information environment, access, retention, version authority, and external release become difficult to control consistently. Project-based work adds further complexity because participants and responsibilities may change across stages, while external parties may require selected

documents for limited purposes. Access should be linked to role, information category, workflow stage, and authorized purpose rather than granted as broad or permanent permission (Saltzer & Schroeder, 1975; Sandhu et al., 1996).

2.6.4. Implications for Secure Digital Workflow Design

The literature suggests that secure digital workflow design for SMEs should be guided by contextual fit, proportionality, usability, and governance clarity (Metin et al., 2024; OECD, 2021). The objective is not to reproduce the infrastructure of a large enterprise. It is to establish maintainable controls that protect the information states and decisions carrying the greatest operational or security significance.

A proportionate workflow should identify the current authoritative document, separate working, approved, held, canceled, and historical information, define upload, review, approval, and release authority, apply role-based access to sensitive information, preserve traceable records of decisions and changes, and control sharing with external parties (ISO, 2018; Whyte et al., 2016). Not every action requires an elaborate approval procedure, but actions that determine document authority, disclose restricted information, or permit external execution require clear responsibility and evidence.

Usability is essential to sustained adoption. Workflow controls should correspond to how professional roles actually perform their work (Adams & Sasse, 1999; Alter, 2014). Role-specific interfaces and permissions can reduce administrative burden while limiting unnecessary exposure. Secure workflow design should also reduce dependence on individual memory by using status labels, histories, contextual notes, and explicit responsibilities. These mechanisms support continuity without replacing professional judgment.

External collaboration must be included in the design rather than treated as an exception. A secure workflow should distinguish between internal records and information authorized for release to clients, consultants, suppliers, or manufacturers. Providing external parties with only the information required for their role can support collaboration while reducing unnecessary disclosure (Saltzer & Schroeder, 1975; European Union, 2016, Art. 5(1)(c)).

2.6.5. Synthesis for the Professional Context

The literature reviewed in this theme shows that SME digital transformation and cybersecurity are shaped by organizational scale, limited specialist resources, overlapping roles, concentrated authority, tacit knowledge, external dependency, and project variability (OECD, 2021; Hobday,

2000; Eller et al., 2020). These conditions can support flexibility, but they can also increase reliance on informal judgment and individual memory.

For specialized natural stone project delivery, these insights are relevant. The work combines design coordination, iterative shop-drawing development, commercial information, international fabrication, shipping, and site activity. It also involves a small professional structure and an extended network of external participants who require different information at different stages.

The literature provides useful analysis of SME digital transformation and cybersecurity, but it offers limited direct examination of secure workflow governance within specialized natural stone professional practice. It does not explain in sufficient detail how document authority, role-based access, approval traceability, and external release should be combined within a proportionate workflow for this context. Nor is this gap closed by the standards and frameworks reviewed earlier. ISO 19650 addresses information-container governance for BIM-enabled construction delivery; ISO/IEC 27001 and NIST SP 800-53 address organizational security controls at enterprise scale; and the GDPR states a legal obligation without prescribing an operational model. None of these was designed for a small, specialized, non-BIM professional practice operating an international fabrication supply chain. This gap supports the study's focus on a contextually aligned secure digital workflow embedded within the operational realities of a specialized project-based professional practice.

2.7. Research Gap

The literature reviewed in this chapter offers useful insight into digital transformation, workflow and document governance, cybersecurity, Action Research, and the organizational conditions of SMEs. However, when these themes are considered together, a more specific gap becomes visible. The gap is not the absence of literature in these areas individually. It lies in the limited integration of these areas within a single, context-specific examination of secure workflow practice in a small, specialized, document-intensive project environment.

Digital-transformation literature establishes that transformation extends beyond technology acquisition and involves changes in organizational strategy, capability, processes, and value creation (Bharadwaj et al., 2013; Vial, 2019; Garzoni et al., 2020). Project-management literature also connects digital transformation with governance, leadership, methods, and socio-technical integration (Chen et al., 2025). However, these perspectives provide less detailed

explanation of how digital transformation is enacted through the routine control of documents, revisions, approvals, role responsibilities, and external information release within a live specialist project.

Workflow and document-management literature demonstrates the importance of repositories, digital objects, lifecycle information governance, approval processes, and document authority (Whyte & Lobo, 2010; Rezgui et al., 2013; Whyte et al., 2016). Formal standards extend this further: ISO 19650 defines information-container states, status codes, and authorized transitions, but frames them for BIM-enabled, multi-party construction delivery (ISO, 2018). This literature also shows that centralized storage does not automatically resolve fragmented practice. Live work may continue outside formal systems, while mixed information formats, organizational boundaries, and contractual responsibilities complicate integration. However, workflow literature does not always connect document authority directly with cybersecurity and data protection. Version control, approval traceability, role-based access, confidentiality, and controlled external release are often treated across separate technical or managerial domains rather than as interdependent parts of one professional workflow.

Cybersecurity literature provides well-developed principles concerning access control, confidentiality, integrity, accountability, human factors, and supply-chain risk (Von Solms & Van Niekerk, 2013; Saltzer & Schroeder, 1975; Sandhu et al., 1996; Adams & Sasse, 1999; ENISA, 2021). Control frameworks and regulation define what must be protected and what must be achieved (Joint Task Force, 2020; ISO/IEC, 2022; European Union, 2016). Sector-specific research also identifies the need for greater cybersecurity attention within architecture, engineering, and construction environments (Mantha & García de Soto, 2021). However, much of this literature operates at the level of information systems, organizational frameworks, threats, or large supply-chain relationships. It provides less direct evidence of how workflow-level cybersecurity is enacted in a small professional practice through everyday document handling, approval authority, role-specific visibility, and restricted release to external project participants.

SME literature further shows that smaller organizations face resource limitations, overlapping responsibilities, uneven digital maturity, and difficulty translating broad governance frameworks into sustainable practice (Eller et al., 2020; OECD, 2021; Hobday, 2000; Metin et al., 2024). These studies support the need for proportionate and context-sensitive digital

arrangements. However, they provide limited detail on the design and evaluation of secure document workflows within specialized, project-based professional SMEs.

Action Research literature provides the methodological basis for examining organizational problems through planned action, observation, reflection, and practitioner learning (Lewin, 1946; Reason & Bradbury, 2008; Coghlan & Brannick, 2014), together with criteria for judging the validity of such inquiry through recoverability rather than repeatability (Checkland & Holwell, 1998). Yet the literature reviewed offers limited direct examination of practitioner-led Action Research used to integrate digital workflow transformation, document governance, and workflow-level cybersecurity in one live specialist project.

These limitations are especially relevant to natural stone project delivery. This context combines design interpretation, shop-drawing development, iterative technical approval, pricing and change decisions, international fabrication, shipping coordination, site verification, and the exchange of commercially and contractually sensitive information. It requires coordination across professional, organizational, and geographical boundaries. The reviewed literature does not provide a directly applicable model explaining how a small natural stone professional practice should combine structured workflow stages, authoritative document versioning, approval and revision traceability, differentiated role responsibilities, controlled access to sensitive information, restricted external release, and proportionate evidence for evaluating operational change.

The gap therefore lies at the intersection of four bodies of guidance, none of which was designed for this setting. The academic literature supplies principles without a proportionate implementation model. ISO 19650 supplies a document governance model, but for BIM-enabled construction delivery. ISO/IEC 27001 and NIST SP 800-53 supply security controls, but at enterprise scale. The GDPR states a legal obligation to embed data protection by design, but it does not provide an operational method. What remains unexamined is how a small, specialized, non-BIM professional practice that operates an international fabrication supply chain can combine these requirements into one workable workflow, and what evidence can reasonably be produced to evaluate it.

This study addresses that gap by designing, implementing, and evaluating a secure digital workflow in one live natural stone project. The intervention translated these requirements into a governed operational workflow that defined role responsibilities, document categories, batch statuses, approval authority, version rules, access boundaries, and controlled external release.

Cybersecurity was treated as part of everyday workflow practice rather than as a separate technical objective. The study was conducted through practitioner-led Action Research within one bounded cycle.

The contribution is context-specific and analytically transferable rather than universal. It lies in examining how digital transformation, workflow governance, document control, and workflow-level cybersecurity can be integrated within the operational realities of a small, specialized natural stone professional practice. This provides the conceptual bridge between the literature reviewed in this chapter and the methodology presented in Chapter 3.

Chapter 3: Research Design and Methodology

3.1. Research Philosophy and Approach

This study adopted an applied, pragmatic, and practice-based research orientation. It was grounded in a defined professional problem within a small firm delivering natural stone projects: the need to improve the organization and governance of project information through a secure digital workflow (Costley et al., 2010). The research was both investigative and practical. It examined how the intervention operated within a live professional setting while generating knowledge relevant to the development of professional practice.

A pragmatic research position was appropriate because the research question required attention to both observable workflow activity and the organizational conditions within which that activity occurred. Pragmatism supports the selection of forms of inquiry that are useful for understanding action in its practical context (Morgan, 2014; Feilzer, 2010). The study was not based solely on objective measurement or solely on subjective professional interpretation. Instead, it drew on complementary evidence selected according to its relevance to the problem under investigation.

The study used a qualitative-dominant mixed-data approach (Johnson et al., 2007). Qualitative evidence provided the main basis for understanding workflow processes, document-handling practices, implementation conditions, and practitioner learning. This was supported by structured categorical indicators and descriptive numerical system metrics. These evidence types were integrated within one Action Research design rather than treated as separate qualitative and quantitative studies (Creswell & Plano Clark, 2018).

Action Research was selected as the overarching methodology because it allowed inquiry to be integrated with planned professional intervention. This aligned with the applied and pragmatic orientation of the study, as knowledge was developed through the design, implementation, observation, and reflection of change in the organization (Reason & Bradbury, 2008; Coghlan & Brannick, 2014). The study implemented one bounded Action Research cycle, which is explained in Section 3.2.

The study also recognized professional knowledge as situated and context-dependent (Schön, 1983). Workflow operation was influenced by the organization's size, existing responsibilities, project structure, working practices, and relationships with external stakeholders. The findings were interpreted within these conditions rather than presented as universally applicable

conclusions. Their wider relevance is analytical and conditional, depending on the similarity of other organizational, workflow, and supply-chain contexts (Lincoln & Guba, 1985; Yin, 2018).

Finally, the study adopted a cautious position regarding causality. It examined changes associated with the introduction of the secure digital workflow, but it did not use an experimental design or claim that the intervention independently caused every observed outcome (Checkland & Holwell, 1998; Susman & Evered, 1978). The methodology supported practical inquiry while maintaining appropriate limits on causality, generalizability, and transfer beyond the study context.

3.2. Action Research Design

The study employed a practitioner-led Action Research design structured around the interconnected phases of planning, action, observation, and reflection (Kemmis et al., 2014; Coghlan & Brannick, 2014). This structure provided a systematic means of linking the identified professional problem with the design, implementation, and evaluation of the secure digital workflow.

Although Action Research is often represented as a spiral involving successive cycles, this study implemented one bounded cycle in one live natural stone project. This reflected the defined scope of the research, the duration of the intervention project, and the operational capacity of the organization. The study does not claim that several independent Action Research cycles were completed (Checkland & Holwell, 1998; Hammersley, 2004).

During the planning phase, the recurring workflow problems were defined and the purpose-built digital system was configured around eight workflow stages (see Appendix A). Planning included the definition of document categories, role responsibilities, access boundaries, batch-status classifications, approval authority, version-control rules, and controlled external-release procedures. These design elements were derived from the governance principles reviewed in Chapter 2 rather than devised ad hoc. Batch-status classification and PM-controlled promotion of authoritative drawings were informed by the broader information-management logic reflected in ISO 19650, particularly the need to distinguish working information from authorized information, without claiming full ISO 19650 implementation. The four-role permission structure applied role-based access control and the principle of least privilege in a proportionate way. The four internal roles received the operational project information required

for their responsibilities. The project owner's name and personal contact information were not included in PUBLIC records or attachments. Detailed pricing, contractual records, complete document histories, and external release authority were restricted according to role and purpose (Sandhu et al., 1996; Saltzer & Schroeder, 1975). The research objectives and evaluation framework were also established at this stage so that subsequent observation would be guided by predefined areas of inquiry rather than by retrospective judgment alone. This prior declaration of the intervention, the evidence sources, and the interpretive framework is what allows the single cycle to satisfy the recoverability criterion set out in Section 2.5 (Checkland & Holwell, 1998).

The action phase involved implementing the secure digital workflow within the selected project. The system was introduced into routine professional activity and used to coordinate project documentation, approvals, revisions, access, and authorized release across the workflow stages. Initial orientation was provided to support understanding of the new procedures and role responsibilities (Adams & Sasse, 1999). As live use progressed, limited procedural refinements were introduced in response to observed uncertainty, including reinforced version-entry guidance, additional role-specific support, and a concise internal workflow handbook (see Appendices D and H). These refinements did not alter the central intervention because the workflow structure, research objectives, and evaluation framework remained unchanged (Kemmis et al., 2014; Checkland & Holwell, 1998).

The observation phase examined how the intervention operated during project delivery. Attention was directed toward document status clarity, version handling, approval and revision traceability, role-based access, coordination activity, and controlled information release. Observation occurred alongside implementation rather than as a wholly separate event, which was appropriate to the live professional setting (Coghlan & Brannick, 2014; Schön, 1983). The evidence sources and collection procedures are detailed in Section 3.5.

The reflection phase involved critical consideration of the relationship between the planned workflow and its operation in practice. The researcher examined implementation challenges, procedural refinements, observed role-specific adoption patterns, professional learning, and the influence of the insider Project Manager position on the design and interpretation of the study (Brannick & Coghlan, 2007; Finlay, 2002).

Iterative learning occurred within the single bounded cycle through the relationship between action, observation, and reflection. Adjustments were made where implementation revealed the

need for clearer guidance or procedural reinforcement. However, these adjustments did not constitute separate cycles because they were not accompanied by new research objectives, redesigned interventions, or independent evaluation periods (Checkland & Holwell, 1998; Hammersley, 2004). This distinction preserves the adaptive character of Action Research without overstating the methodology. The study presents one documented cycle in which the intervention was planned, implemented, observed, and reflected upon within the boundaries of a live project.

3.3. Research Context and Participants

The research was conducted within a small project-based professional practice specializing in natural stone architectural and hardscape projects. Its work involved design coordination, shop-drawing development, technical review, pricing coordination, international fabrication, shipping, and site verification. Project delivery depended on the controlled movement of technical, commercial, and operational information between internal roles and external stakeholders (Hobday, 2000; Rezgui et al., 2013).

Shop drawings and related project documentation were important to this process. They developed through repeated submission, review, revision, and approval before being used to support fabrication, delivery, and site verification. The professional context was document-intensive and required clear responsibility for information preparation, approval, access, and release (Whyte & Lobo, 2010; Carlile, 2002).

The intervention project involved four direct operational system-user roles: Project Manager (PM), Engineering Team (ENG), Site Team (SITE), and Shipping Control (SHIP) (see Appendix A). These roles reflected existing organizational responsibilities rather than research-created categories. Each role interacted with the workflow according to defined operational duties and information requirements. The role structure was designed to provide access to information required for project delivery while restricting access to information outside each role's responsibility (Sandhu et al., 1996; Saltzer & Schroeder, 1975).

The Project Manager held full system access and acted as the main coordination and governance role. The PM managed project-level information, coordinated external review and feedback, reviewed submitted documentation, promoted authoritative approved document batches into the controlled repository, and controlled external release. This included determining when approved information was suitable for manufacturing use and ensuring that

external parties received only documentation authorized for their role and purpose. Pricing and project-related financial records were also managed in the workflow by the PM. A separate pricing and finance function existed in the organization but did not hold a direct system-user role. Financial outputs were provided to the PM through the established organizational process and were then managed in the workflow under the relevant access restrictions (see Appendix E, Section 2).

The Engineering Team prepared shop drawings, responded to technical comments, revised drawing packages, and submitted engineering outputs through the workflow. ENG had access to the project information and design inputs required for these activities and to the latest approved drawing information relevant to continuing technical work. ENG did not have access to project pricing records or fabrication and shipping records (see Appendix E).

The Site Team was responsible for site verification, including checking relevant site conditions and referring to the current approved documentation required for field coordination. SITE also supported inspection of delivered stone elements against the information available for site use. SITE had access to the latest approved drawings, relevant public coordination records, the latest confirmed pricing summary on a read-only basis, and the latest fabrication status required for operational coordination. SITE did not have access to full pricing history, contractual records, the complete PM-controlled drawing-repository history, or the complete fabrication and shipping history. Although SITE could view PUBLIC timeline records and their attachments, its operational drawing reference was limited to the latest PM-promoted APPROVED drawing. The project owner's name and personal contact information were not included in PUBLIC records or attachments (see Appendix E).

Shipping Control was responsible for executing manufacturer communication and for fabrication and delivery-related workflow activity. After PM authorized the current authoritative APPROVED shop-drawing batch for manufacturing use, SHIP transmitted those authorized drawings to the manufacturer through the organization's external email process. The manufacturer had no direct access to the internal workflow system. SHIP did not determine drawing authority or independently authorize external release and subsequently uploaded or tracked fabrication and shipping records within the workflow. SHIP did not have access to pricing records, contractual records, or the complete PM-controlled drawing-repository history. Although SHIP could view PUBLIC timeline records and their attachments, its operational manufacturing reference was limited to the latest PM-promoted APPROVED shop-drawing

batch authorized for manufacturing use. The project owner's name and personal contact information were not included in PUBLIC records or attachments (see Appendix E).

The study examined workflow operation across these four direct system-user roles in one live natural stone project (see Appendix F). The analysis focused on role-coded workflow activity and organizational processes rather than individual employee performance or personal characteristics. Although routine professional interaction occurred during delivery, the study did not conduct interviews, questionnaires, or focus groups. This reflected the study's focus on workflow operation rather than user perception, and on the role-coded activity generated by the system rather than on self-reported accounts. It also limits the claims that can be made about user experience and acceptance, a boundary addressed in Section 3.9. Clients, consultants, manufacturers, and other external stakeholders interacted with project outputs or contributed information to the wider delivery process, but they were not direct users within the internal system-role structure and their personal views or performance were not evaluated.

The researcher operated within the Project Manager role and held an insider practitioner position (Brannick & Coghlan, 2007). This provided direct access to the professional setting and workflow records, but it also required transparent reporting of the researcher's operational and analytical responsibilities. The study setting was a bounded live professional environment rather than a controlled experimental setting, allowing the secure digital workflow to be examined under actual project-delivery conditions within a clearly defined organizational, role, and system boundary.

3.4. Planned Intervention

The intervention comprised a purpose-built secure digital workflow implemented in one live natural stone project. It was designed to replace fragmented document-handling practices with a structured system for coordinating project information, document versions, approvals, access responsibilities, and authorized external release.

The intervention addressed the three outcome dimensions in the research question: efficiency, accuracy, and data protection. Efficiency was approached through more centralized access to project information and reduced reliance on repeated searching and manual confirmation. Accuracy referred specifically to document-use accuracy: the ability of project roles to identify and use the appropriate authorized information. Data protection was addressed through role-based access, information segregation, traceable workflow records, and controlled release to

external parties. The intervention did not assess the technical correctness of architectural or engineering content and did not constitute a comprehensive technical cybersecurity program. Its scope was limited to workflow-level confidentiality, document integrity, access control, traceability, and authorized information release.

The digital workflow organized project activity into eight stages: Project Initiation; Design Inputs and Drawings; Engineering Outputs, including shop drawings; Pricing and Costing; Client Review and Revisions; Site Verification; Approval and Contractual Confirmation; and Manufacturing Release and Shipping. Each stage was linked to defined information types, operational responsibilities, and access boundaries, reflecting information-management principles adapted to the organization's workflow context (ISO, 2018). The stages provided a project-lifecycle structure but did not imply that professional activity was entirely linear. Where an accepted change affected controlled documentation, the workflow could return to an earlier engineering and approval stage before further manufacturing release. The complete stage and access structure is documented in Appendix A (Sections 1 and 2).

Documents were managed through structured batch entries rather than by overwriting previous files. Each batch included identifying information such as date, version reference, and a contextual note describing the purpose or relevant change. Engineering drawing packages were first submitted by ENG through the project timeline. Submission did not itself make a drawing package authoritative. The PM reviewed submitted information and promoted the appropriate batch into the controlled drawing repository under either APPROVED or HOLD status. This adapted the broader information-management distinction between submitted information and authorized information to the organization's workflow context (ISO, 2018).

Drawing-batch status was governed through three classifications. APPROVED identified a PM-promoted drawing batch retained within the controlled repository. HOLD identified information awaiting further review, clarification, or revision. CANCELED was available for a drawing batch explicitly withdrawn or discontinued by a documented project decision. In the intervention project, CANCELED status was not applied to any drawing batch. Three APPROVED drawing batches and one HOLD batch were retained (see Appendix E, Section 1). Earlier APPROVED batches were not deleted or reclassified when a later approval was issued. They remained as historical approval records, while the most recent PM-promoted APPROVED batch served as the current authoritative operational reference (Whyte et al., 2016).

Pricing records used a separate status vocabulary: ESTIMATES for preliminary pricing, INVOICES for confirmed pricing, HOLD for items awaiting a client decision, and CANCELED for declined or withdrawn commercial items (see Appendix E, Section 1). This distinction between drawing-batch status, pricing status, and whole-project classification was maintained throughout the system (ISO, 2018). Whole-project classifications such as NEW, ESTIMATING, RFP, FINISHED, ON_HOLD, and CANCELED operated at project level and were not equivalent to individual drawing or pricing statuses.

The intervention connected revision activity to documented approval decisions. Each significant revision was entered as a new submission or batch rather than replacing an earlier record. Accepted changes affecting controlled manufacturing documentation required a revised engineering submission and subsequent PM promotion of a new authoritative APPROVED batch. Declined commercial items could be retained under the appropriate pricing status without initiating a new engineering revision or drawing-approval cycle because they had not been authorized for implementation. This ensured that technical revision activity occurred only where a change had been authorized for implementation (see Appendix E, Section 3).

Role-based access controls were incorporated into the workflow architecture (Sandhu et al., 1996; Saltzer & Schroeder, 1975). Operational project information, including relevant drawings, the project address, builder and architect details, and their professional contact information, was available to the four authorized internal roles through the PUBLIC workflow. The project owner's name and personal contact information were not included in PUBLIC records or attachments. PM held full project access and controlled authoritative drawing promotion, pricing records, approval documentation, and external release. ENG could submit technical packages and access the information required for drawing preparation, but could not access pricing records or fabrication and shipping histories. SITE could view the latest approved drawing, current operational records, the latest confirmed pricing summary on a read-only basis, and the latest fabrication status, but could not access complete pricing history, the complete PM-controlled drawing-repository history, or the complete fabrication and shipping history. SHIP could access the latest PM-authorized APPROVED manufacturing information and manage fabrication and delivery records, but could not access pricing records, contractual records, or the complete PM-controlled drawing-repository history (see Appendix E, Section 2).

The system recorded documented workflow activity through role-coded and timestamped records (Joint Task Force, 2020). Timeline entries could include contextual notes and relevant attachments, allowing recorded submissions, updates, approvals, and operational actions to be reconstructed. These records supported traceability of activity conducted through the system, but they were not used as evidence of every communication or decision that may have occurred outside it (Alter, 2014).

External document release remained under PM authority. During the intervention project, original architectural drawings were retained within the governed internal workflow and were not included in manufacturing communications. Only shop drawings from the current authoritative PM-promoted APPROVED batch were authorized for fabrication. The workflow system did not transmit files directly to the manufacturer, and the manufacturer had no direct system access. Following PM authorization, SHIP transmitted the authorized shop drawings through the organization's external email process and subsequently uploaded and managed fabrication and delivery-tracking batches. This preserved the distinction between PM authority, SHIP execution of external communication, and subsequent fabrication and logistics recording (see Appendix E, Section 3; Appendix F, Stage 8).

Initial orientation was provided to explain the workflow stages, role responsibilities, document-status conventions, and access boundaries. During implementation, some procedural uncertainty arose from unfamiliarity with the new structure (Lapointe & Rivard, 2005; Adams & Sasse, 1999). Additional role-specific guidance was provided, and a concise internal workflow handbook was prepared to clarify version-entry conventions, update responsibilities, document-status use, and access boundaries (see Appendices D and H). These actions supported implementation but did not change the fundamental workflow architecture. They were procedural refinements within the action phase of the single Action Research cycle (Kemmis et al., 2014; Checkland & Holwell, 1998).

The intervention was bounded to the governance and operational movement of project information in one live project. It included document intake, shop-drawing submission, pricing coordination, revision and approval records, site-verification activity, controlled manufacturing release, and fabrication and delivery tracking. It did not redesign architectural content, perform structural or engineering calculations, control manufacturing operations, replace the organization's financial accounting system, manage the overall project schedule, or control the internal systems of clients, consultants, or manufacturers. The intervention was designed to

govern the organization's own project information and authorized outputs rather than every process in the wider project network.

3.5. Data Collection Methods

Data collection was designed to document how the secure digital workflow operated in one live natural stone project and to support comparison with recurring pre-intervention workflow conditions identified in the organization. Consistent with the applied Action Research design, evidence was collected through routine professional activity rather than through an experimental or simulated setting.

The study used a qualitative-dominant mixed-data approach. Qualitative process evidence provided the main basis for understanding workflow operation, document handling, implementation conditions, and practitioner learning. This was supported by four predefined categorical indicators and descriptive numerical metrics generated from the workflow system. The evidence base comprised five complementary sources: structured practitioner observation, project and system documentation, reflective practitioner records, predefined categorical indicators, and descriptive system metrics. These sources served different evidential purposes and were not used as interchangeable.

3.5.1. Retrospective Baseline Evidence

The study did not include a same-project pre-intervention measurement period. Instead, it used a retrospectively documented organizational baseline derived from recurring workflow conditions observed across more than 200 earlier projects during 11 years of organizational practice, including five years of direct responsibility in the Project Manager role (see Appendix C.1). The use of accumulated practitioner knowledge as a legitimate starting point for inquiry reflects the insider researcher's pre-understanding of the organizational setting (Brannick & Coghlan, 2007).

The baseline concerned recurring patterns associated with difficulty identifying the latest approved document, uncontrolled circulation of document versions, weak traceability of revisions and approvals, fragmented storage and retrieval, and inconsistent control over access and external information sharing. Representative incidents were used to illustrate these wider organizational patterns, but the study did not claim that every earlier project exhibited the same problems or that a precise proportion of projects was affected.

The baseline was formalized through structured indicator and comparison records. It represented a retrospective synthesis of recurring professional evidence rather than a contemporaneous observation of the intervention project before the new workflow was introduced. This distinction limits the comparison. The baseline and post-intervention evidence were generated under different evidential conditions and were used for structured descriptive comparison, not experimental equivalence or causal isolation (Checkland & Holwell, 1998).

3.5.2. Prospective Intervention Evidence

Post-intervention evidence was collected prospectively during the live project from 2 February 2025 until formal project closure on 27 February 2026 (see Appendix E, Section 1). Evidence was generated as the project progressed through the relevant workflow stages, including project initiation, design-input management, engineering submissions, pricing coordination, review and revision, site verification, approval, fabrication, and delivery tracking.

No separate artificial testing period was introduced. Evidence arose from actual project activity carried out through the workflow and from the associated professional records generated during delivery. Early implementation observations, including the need for additional role guidance and clarification of version-entry conventions, were retained as evidence of the adoption process. The final indicator assessment reflected the workflow after it had operated through the active project stages, rather than being based only on first-use behavior.

3.5.3. Structured Practitioner Observation

Structured practitioner observation was carried out by the researcher throughout implementation. The researcher observed workflow processes as part of the normal Project Manager role while maintaining records focused on process operation rather than individual staff performance (Coghlan & Brannick, 2014).

Observation addressed whether current approved documentation could be identified, how submissions and revisions were entered, how approvals and changes were recorded, how operational roles accessed required information, whether access boundaries were maintained, how authorized documents were released externally, and where procedural clarification was required. Practitioner observations were documented within the structured comparison and indicator records presented in Appendices C.1 and C.2. No separate field-note file was maintained. As far as practicable, those records distinguished direct observation from later interpretation.

Routine conversations and guidance occurred as part of normal project coordination and system support. These interactions provided operational context but were not used as a separate interview or participant-feedback dataset. No formal interviews, questionnaires, or focus groups were conducted.

3.5.4. Project and System Documentation

Documentary evidence was collected from professional records generated or managed during the project. This included drawing submissions, controlled drawing batches, pricing batches, approval and revision records, fabrication and delivery records, and role-coded timeline activity. The purpose was to establish how information moved through the workflow and whether the defined governance rules were represented in the project record.

Particular attention was given to document and batch identifiers, dates and contextual notes, batch classifications and statuses, approval and revision sequences, the relationship between submitted and authoritative records, role-coded actions, access arrangements, and documented external-release activity. System records were contemporaneous in the sense that they were generated or entered as workflow actions occurred. They reduced reliance on later recollection by preserving role and timestamp information. However, they documented activity carried out through the system and were not assumed to capture every communication or professional decision occurring outside it (Alter, 2014).

Appendices B and F contain selected or representative extracts from these records. Appendix E provides the system-level evidence ledger, including file, batch, access-rule, and timeline summaries. The complete operational records remained within the live workflow system.

3.5.5. Reflective Practitioner Records

The study used one structured reflective practice record developed across the Action Research cycle. The record is organized by intervention phase rather than by date and is presented in Appendix D. Appendix D is the only separate reflective evidence document used for this part of the study. No separate dated diary or additional reflective file exists. The record documented implementation decisions, procedural difficulties, orientation and support provided, adjustments to guidance, developing interpretations, and professional learning arising from the intervention.

The reflective record supported reflexivity by making the practitioner-researcher's influence and assumptions more visible (Schön, 1983; Finlay, 2002). It also documented why particular

procedural responses were introduced during implementation. The reflective record was not used as independent verification of workflow performance or as evidence of the personal perceptions of other operational users. Its primary evidential function was to support analysis of researcher learning, positionality, and interpretation. Appendix D includes a clearly labeled retrospective positionality statement rather than presenting that analysis as a contemporaneous dated entry.

3.5.6. Predefined Indicators and Descriptive Metrics

Four indicators were defined to provide a consistent structure for comparing baseline and post-intervention conditions: Clarity of the Latest Approved Version; Frequency of Document-Related Errors; Ease of Tracking Approvals and Revisions; and Information Governance and Data Protection Control. The second indicator was bounded specifically to document-related errors arising from uncontrolled version circulation. It did not assess the technical correctness of architectural drawings, engineering calculations, fabrication details, or installed work.

The indicators were recorded as categorical descriptive assessments rather than statistical measurements. They were designed to make the comparison transparent and consistent without introducing numerical precision unsupported by the design. Indicator definitions, baseline and post-intervention ratings, supporting observations, and tracking records are presented in Appendices C.1 and C.2.

Descriptive numerical metrics were collected from the workflow system to characterize the scale and distribution of recorded activity. These included file totals by controlled section, document- and pricing-batch counts and statuses, fabrication-batch counts, role-coded timeline records, attachment counts, access-rule counts, and project-status information. These metrics described what was present in the intervention record. They were not used as inferential statistics and did not provide independent measures of productivity, causality, or project success. For example, the number of records generated by a role indicated documented workflow activity but did not, by itself, establish the quality or efficiency of that role's performance.

3.5.7. Operational Users, Storage, and Data Collection Boundaries

The study boundary included four direct operational system-user roles: Project Manager, Engineering Team, Site Team, and Shipping Control. Their participation occurred through normal use of the workflow and the role-coded operational records generated during project

delivery. The study examined role-level activity and workflow processes rather than individual employee performance or personal opinion.

The pricing and finance function contributed project-related outputs indirectly through the Project Manager but did not hold a direct system-user role. Clients, consultants, manufacturers, and other external parties were not used as research participants or separate data sources. Where their inputs or decisions formed part of the project record, these were examined only at the documentary and process level.

Practitioner observations were documented in the structured comparison and indicator records presented in Appendices C.1 and C.2, while reflective material was documented in Appendix D. No separate observation-note or reflective file existed beyond these documents. Indicator records were maintained in consistently labeled tracking tables. System-generated and project records remained within the governed digital workflow and associated professional storage arrangements. Research records used for analysis were limited to anonymized or process-level information. Identifying client, employee, property, contractual, and commercially sensitive details were excluded from the submitted evidence.

Data collection was bounded to one organization, one intervention project, four operational system-user roles, and workflow activities relevant to the research question. The study collected evidence concerning document preparation and submission, version and batch governance, approvals and revisions, role-based access, controlled information release, fabrication and delivery tracking, and observable coordination activity. It did not collect or assess formal employee or stakeholder perceptions, individual performance, technical correctness of drawing or engineering content, network or penetration-testing evidence, financial return, productivity percentages, measured labor-hour savings, overall project-duration reduction, contractual performance, or long-term organizational change beyond the intervention project. These boundaries maintained alignment between the evidence collected and the claims the research was designed to support.

3.6. Data Analysis Strategy

The analysis strategy examined the operation of the secure digital workflow through a structured comparison between the retrospectively documented organizational baseline and the prospectively recorded evidence from the intervention project. Consistent with the qualitative-

dominant mixed-data design, structured qualitative comparison provided the main analytical approach, supported by categorical indicators and descriptive numerical system metrics.

The analysis was explanatory and practice-oriented. Its purpose was to identify how documented workflow conditions differed, what governance mechanisms were associated with those differences, and what professional learning arose through the Action Research cycle. It did not involve inferential statistics, experimental testing, or formal causal attribution.

3.6.1. Analytical Framework

The analysis was organized around the three outcome dimensions stated in the research question: efficiency, accuracy, and data protection. These terms were interpreted according to the controlled terminology of the study. Efficiency concerned coordination activity, document retrieval, repeated clarification, and information-handling effort. Accuracy referred to document-use accuracy rather than the technical correctness of drawing or engineering content. Data protection concerned workflow-level confidentiality, integrity, role-based access, traceability, and controlled external release.

The analysis was further structured by four predefined indicators: Clarity of the Latest Approved Version; Frequency of Document-Related Errors; Ease of Tracking Approvals and Revisions; and Information Governance and Data Protection Control. These indicators provided consistent analytical categories for examining baseline and intervention evidence. The analysis did not depend on themes generated retrospectively after the results were known (Checkland & Holwell, 1998).

3.6.2. Structured Qualitative Comparison

Qualitative evidence was examined through a structured comparative process. Baseline accounts, practitioner observations, project documents, system records, and reflective records were organized according to source, evidential function, workflow stage, and relationship to the research objectives.

The comparison examined how document status was established, how the latest approved information was identified, how revisions and approvals were recorded, how responsibilities were distributed across roles, how access to sensitive information was governed, how documentation was released externally, and how workflow activity could be reconstructed from available records.

The analysis considered both the existence of new controls and their documented operation. For example, a role-based permission rule demonstrated system capability, while role-coded activity and document records provided evidence of how that capability operated during the intervention project. Inconsistencies and implementation difficulties were also retained in the analysis. Early incomplete contextual-note entries, the need for additional role guidance, and the development of the workflow handbook were used as implementation evidence rather than removed from the account (Lincoln & Guba, 1985).

The comparison was not presented as an equivalent same-project pre-test and post-test. The baseline was retrospective and represented recurring patterns across earlier projects, while the intervention evidence was documented prospectively during one live project. Similarity in organization, project type, and practitioner role strengthened contextual comparability, but did not remove all possible contextual differences.

3.6.3. Analysis of the Predefined Indicators

The four indicators were analyzed through categorical comparison between baseline and intervention conditions. The categories were descriptive rather than numerical scores. LOW and HIGH were used for the positively framed indicators, while RECURRING and NONE OBSERVED were used for the negatively framed Frequency of Document-Related Errors indicator. These indicator-specific descriptors were not treated as points on a single numerical or ordinal scale. The recorded comparisons were as follows: Clarity of the Latest Approved Version moved from LOW to HIGH; Frequency of Document-Related Errors arising from uncontrolled version circulation moved from RECURRING to NONE OBSERVED; Ease of Tracking Approvals and Revisions moved from LOW to HIGH; and Information Governance and Data Protection Control moved from LOW to HIGH.

Each categorical descriptor was interpreted against its defined operational condition and supporting evidence. HIGH did not indicate perfect or universal performance; it indicated that the relevant positive condition was consistently evidenced in the documented intervention project. RECURRING indicated that document-related errors arising from uncontrolled version circulation were identified as a recurring condition in the retrospective baseline evidence. NONE OBSERVED indicated that no such error was identified during the intervention observation period. It did not mean that technical errors were impossible or that every category of professional error had been eliminated. Appendices C.1 and C.2 provided the primary indicator comparison records.

3.6.4. Analysis of Descriptive System Metrics

Numerical system records were analyzed descriptively to establish the scale, distribution, and status of documented workflow activity. These included file totals within controlled sections, drawing-batch counts, pricing-batch counts, fabrication-batch counts, batch classifications and statuses, role-coded timeline activity, attachment totals, access-control rules, and project-classification records.

The metrics were used to describe the implemented workflow and support interpretation of qualitative evidence. For example, drawing-batch counts showed that several approved records were retained without overwriting, while timeline records demonstrated activity across all four operational roles. Counts were not used as direct measures of effectiveness. A larger number of records did not necessarily indicate greater efficiency, higher performance, or stronger participation. Metrics were interpreted according to their operational meaning and in combination with documentary and observational evidence. Appendix E functioned as the ledger-of-record for system totals, access rules, batch structures, and claim-to-evidence mapping.

3.6.5. Reflective Analysis

Reflective records were analyzed separately from system-performance evidence. The researcher reviewed the structured reflective practice record to identify professional learning, implementation challenges, difficult decisions, changes in understanding, and practice-based implications arising across the Action Research cycle.

Reflective analysis addressed the initial adoption challenge, the need for clearer role-specific guidance, decisions concerning version and release authority, procedural changes that would be made in a future implementation, and observations concerning how the four roles adapted to the workflow. This analysis supported the professional-learning objective and the reflexive examination of the researcher's insider position. It was not used as independent confirmation of system performance or as direct evidence of the personal perceptions of other operational users. Appendix D provides the submitted structured reflective practice record supporting this part of the analysis, including a clearly labeled retrospective positionality statement.

3.6.6. Evidence-source Convergence and Audit Trail

Findings were developed by comparing complementary evidence sources and assessing whether they supported, qualified, or contradicted one another. This process is described as

evidence-source convergence rather than formal methodological triangulation (Lincoln & Guba, 1985) because the sources formed part of one integrated practitioner-led Action Research design.

For each major analytical claim, the researcher considered the relationship between the predefined indicator condition, structured practitioner observation, project and batch documentation, role-coded and timestamped system records, access-control evidence, descriptive system metrics, and, where relevant, reflective interpretation. Convergence strengthened an interpretation where different sources documented the same operational condition. For example, version clarity was supported by the indicator assessment, retained drawing-batch structure, the distinction between APPROVED and HOLD records, and the access rule directing non-PM roles to the latest approved drawing.

The analysis also distinguished system capability from project-specific use. A permission or visibility scope could exist technically without being used during the project. Claims concerning actual implementation were based on documented project activity, not solely on available system functions. For example, the PRIVATE_PM and PRIVATE_SHIP visibility scopes existed as structural capabilities but were not used during the intervention project; all timeline records were recorded under PUBLIC visibility (see Appendix E, Section 2).

Transparency was supported through a documented relationship between research objectives, evidence sources, indicators, system records, and claims (Lincoln & Guba, 1985). The research objectives, data types, operational-user boundaries, collection methods, and analysis approach were defined before final evaluation and documented through the methodology and supporting appendices. Appendices C.1 and C.2 provided indicator comparisons and tracking records. Appendix D provided reflective evidence. Appendix E provided the ledger-of-record for system totals, access rules, structural evidence, and claim mapping. Appendix B provided selected intervention-execution records, and Appendix F provided representative multi-role activity extracts. Appendices B and F were not used as complete transaction-level records; the full operational records remained within the live system.

3.6.7. Boundaries of Interpretation

The analysis supported strong project-specific statements where evidence was direct and consistent, including whether version ambiguity was observed, whether document-related errors arising from uncontrolled version circulation occurred, whether approval actions were traceable, and whether documented access boundaries operated during the intervention project.

The analysis did not support claims that the intervention independently caused every observed change, that equivalent outcomes would occur in other organizations, that all forms of cybersecurity risk were addressed, that technical drawing accuracy was established, that labor productivity or financial return was measured, or that long-term organizational change was demonstrated beyond the observation period.

Overall, the analysis combined structured qualitative comparison, categorical indicator assessment, descriptive system metrics, reflective analysis, and convergence across complementary evidence sources. This provided a transparent and contextually grounded basis for interpreting workflow change while maintaining clear limits around causality, generalization, and the evidential role of each source.

3.7. Ethics

The study was conducted as practitioner-led Action Research within the researcher's normal professional setting. Its ethical approach reflected the process- and system-focused nature of the inquiry, the researcher's insider position, the use of operational workflow records, and the commercial sensitivity of the project environment.

The study involved four direct operational system-user roles: Project Manager, Engineering Team, Site Team, and Shipping Control. Their participation arose through normal use of the secure digital workflow during project delivery. The research examined role-coded activity and workflow processes rather than the personal performance, attitudes, or characteristics of individual employees. No formal interviews, questionnaires, or focus groups were conducted, and the study did not create a separate dataset of personal testimony or identifiable employee opinions. Routine conversations occurred as part of project coordination, orientation, and system support, but these were not analyzed as formal participant-feedback data.

The researcher occupied both the Project Manager and practitioner-researcher roles. This provided authorized professional access to the project workflow and enabled implementation of the intervention, but it also created a potential power imbalance because the researcher held operational responsibility in the organization (Brannick & Coghlan, 2007). To reduce the ethical implications of this dual role, the study did not ask colleagues to evaluate the researcher, provide personal accounts of their experience, or comment on workplace relationships. It did not assess individual productivity or compare the performance of named employees.

Observations were limited to workflow operation, role responsibilities, information handling, and documented system activity.

Role-coded records were used to describe how functional responsibilities were enacted in the workflow. They were not used to attribute failure, competence, or misconduct to particular individuals. Observations concerning adoption were reported as practitioner observations rather than as independently collected statements of employee perception.

Confidentiality was a primary ethical requirement because natural stone project delivery involved sensitive client, commercial, contractual, architectural, and property-related information. The organization also operated under professional confidentiality obligations and Non-Disclosure Agreements. Although the underlying professional workflow necessarily contained project information required for operational delivery, identifying or commercially sensitive content was not reproduced in the thesis or submitted evidence package.

The research presented evidence at the level of roles, workflow stages, document categories, status records, system counts, and anonymized process extracts. Personal names were replaced by functional role labels such as PM, ENG, SITE, and SHIP (see Appendix F, Section 1). Client identity, project identity, property details, contact information, contractual references, pricing content, and original architectural documentation were excluded or redacted from research outputs. Anonymization reduced the likelihood of identification but was not used as an absolute guarantee of anonymity in the organization, where colleagues might recognize aspects of the project context. The thesis avoided unnecessary operational detail that could reveal individuals, clients, or commercially sensitive information.

The evidence used in the study arose primarily from normal organizational activity and the operation of the secure digital workflow. It included system-generated records, document and batch histories, project documentation, structured practitioner observation, categorical indicators, descriptive system metrics, and reflective practitioner records. System records were analyzed at process and functional-role level and were used only for the research objectives concerning document governance, coordination, access control, traceability, and professional learning. They were not used for employee appraisal, disciplinary assessment, or evaluation of personal behavior.

External stakeholders, including clients, consultants, manufacturers, and suppliers, were not used as direct research participants. Where their decisions or inputs appeared within the

professional record, these were examined only insofar as they formed part of the anonymized workflow process. Their personal views were not collected or analyzed.

The submitted research evidence comprised the anonymized appendices, the implemented workflow application's database and file-storage records, and the signed organizational confirmation retained by the researcher. Practitioner observations were documented in Appendices C.1 and C.2, while reflective material was documented in Appendix D. No separate observation-note or reflective file existed. Access to the underlying professional system remained subject to the role-based controls applied in the organization. The appendices presented anonymized extracts, structured summaries, and system-level totals rather than confidential project content. Data handling followed the principles of data minimization and purpose limitation, and retention and disposal of research records were governed by applicable organizational and institutional data-management requirements.

In line with the doctoral program’s research-governance guidance, the study was treated as exempt from further institutional ethics approval. A completed and signed Research-Ethics Self-Declaration has been submitted to the doctoral program and is held on file. The study used anonymized organizational records at process and functional-role level and did not collect interviews, questionnaires, focus groups, personal testimony, identifiable employee-opinion data, or individual performance data. The submitted evidence was limited to anonymized workflow records, role-coded activity, structured indicators, descriptive system metrics, process-level extracts, and reflective practitioner records.

The Owner/Director provided organizational authorization for the workflow-improvement initiative and for the use of anonymized, process-level organizational evidence. Senior organizational leadership had prior awareness of the recurring professional problems, authorized the intervention before implementation began, remained aware of the project activity throughout, and provided written post-completion confirmation of that prior authorization and organizational awareness. Appendix G documents this organizational awareness and authorization. It establishes permission to undertake the intervention within the company and to use anonymized organizational records for the study.

Appendix G is not presented as individual informed consent on behalf of employees, independent validation of the findings, or permission to use personal testimony that was not part of the study design. It is presented as organizational authorization for the workflow-improvement initiative and for the use of anonymized, process-level organizational evidence.

The intervention was integrated into normal project delivery and did not deliberately alter contractual obligations, client relationships, employment conditions, or individual performance-management arrangements. The ethical approach was proportionate to a bounded, practitioner-led organizational study, but it did not assume that process-focused research was ethically neutral (Costley et al., 2010). The insider role, use of employee-generated operational records, commercial confidentiality, and organizational power relationships required explicit acknowledgment and careful limitation of the evidence and claims.

3.8. Validity, Reliability, and Trustworthiness

Rigor in this study was addressed through criteria appropriate to a qualitative-dominant, practitioner-led Action Research design. The study did not seek statistical validity, measurement reliability, or experimental replicability. Instead, it used Lincoln and Guba's trustworthiness criteria of credibility, dependability, confirmability, and transferability, extended in this study through explicit attention to reflexivity and evidential traceability (Lincoln & Guba, 1985).

These criteria were applied with recognition of the study's methodological boundaries. The research involved one organization, one live intervention project, a retrospective baseline, and an insider practitioner-researcher. Trustworthiness depended on making the evidential basis, research procedures, interpretive decisions, and limitations sufficiently transparent for readers to assess the strength of the findings.

Credibility was supported through sustained engagement with the professional setting and direct observation of the workflow during live project delivery. The researcher's position as Project Manager provided detailed contextual understanding of the organizational problem, operational responsibilities, and implementation conditions. However, professional proximity was not used as sufficient evidence by itself. Interpretations were examined against complementary sources, including structured practitioner observation, project documentation, role-coded system activity, document- and batch-level histories, predefined indicators, and descriptive system metrics.

Credibility was strengthened where these sources converged on the same documented condition. For example, conclusions concerning version clarity were considered in relation to the indicator assessment, retained drawing-batch history, the distinction between APPROVED and HOLD records, and the rule directing operational roles to the latest approved drawing.

Evidence that qualified positive interpretation was also retained, including early procedural uncertainty, incomplete contextual notes, the need for reinforced orientation, and the development of the workflow handbook. Because the study did not use interviews, questionnaires, or focus groups, claims concerning user adaptation were limited to documented role activity and structured practitioner observation rather than presented as independently reported user perceptions.

Dependability was supported through the consistent use of a predefined research structure. The research objectives, four indicators, workflow stages, operational roles, access rules, document classifications, and main evidence sources were established before final evaluation of the intervention. The study maintained a documented relationship between the research objectives, intervention design, evidence collected, predefined indicators, analytical comparisons, and resulting claims. Procedural adjustments introduced during implementation, including reinforced version-entry guidance, additional role orientation, and the internal workflow handbook (see Appendices D and H), were documented rather than treated as separate or unreported interventions. Dependability in this context refers to the transparency and consistency of the research process, not to an expectation that another project would produce identical records or outcomes. This corresponds to the criterion of recoverability rather than repeatability: the intervention, evidence sources, indicators, and interpretive framework were defined before final evaluation and documented in the audit trail, so that an independent reader can trace how the conclusions were reached (Checkland & Holwell, 1998).

Reflexivity and confirmability were important because the insider position created a risk that professional assumptions, operational authority, or commitment to the intervention could influence observation and interpretation. The structured reflective record documented implementation decisions, emerging interpretations, procedural difficulties, professional learning, and changes that the researcher would consider in future practice. Reflective records were not used as independent confirmation of system effectiveness or as evidence of the personal views of other users. Confirmability was instead supported by linking interpretive claims to identifiable documentary, observational, indicator, and system-level evidence. The study does not claim complete researcher neutrality; rather, it seeks to show that interpretations were made transparently and grounded, where possible, in evidence beyond personal recollection (Finlay, 2002).

Evidential traceability was supported by role-coded, timestamped, document-level, and batch-level records preserved through the workflow system. These records supported reconstruction of documented submissions, approvals, revisions, access arrangements, and fabrication or delivery activity. The appendices provided a structured audit trail: Appendices C.1 and C.2 documented indicator definitions, ratings, and supporting comparisons; Appendix D presented the structured reflective practice record; Appendix E provided the ledger-of-record for system totals, access rules, batch structures, and claim mapping; Appendix B provided selected intervention-execution records; and Appendix F provided representative multi-role activity records. Appendices B and F did not reproduce the complete transaction history, and the full operational records remained within the live system. System records reduced reliance on memory, but they were not used as independent external verification or as evidence of every informal communication outside the platform. Organizational authorization in Appendix G confirmed permission and organizational awareness, but it was not used as independent validation of the findings.

The study did not aim for statistical generalization. Transferability was supported through detailed description of the professional context, intervention boundaries, workflow stages, role responsibilities, status rules, access arrangements, and evidence limitations. The findings are transferable only in an analytical and conditional sense (Lincoln & Guba, 1985; Yin, 2018). Readers may assess whether principles such as structured stage-based coordination, disciplined version control, role-appropriate access, traceable approval records, and controlled external release are relevant to comparable organizations. The specific eight-stage structure, role configuration, and technical implementation should not be assumed to apply unchanged to every setting.

The trustworthiness measures strengthened transparency and evidential coherence but did not remove the limitations of the design. The baseline was retrospective, the post-intervention evidence came from one live project, no parallel control project was used, the researcher designed and interpreted the intervention, no independent participant-perception dataset was collected, and no external evaluator replicated the analysis. The findings should be interpreted as credible, documented, and context-specific professional evidence rather than as experimentally verified or universally generalizable conclusions.

3.9. Limitations of the Methodology

The methodological limitations of the study arise from its bounded, practitioner-led Action Research design. These limitations do not invalidate the evidence, but they restrict the conclusions that can reasonably be drawn from it. The findings should be interpreted as context-specific professional evidence rather than as experimental proof or universally generalizable results.

The first limitation concerns the single-project and single-organization design. The intervention was implemented within one natural stone project in one professional organization. This enabled detailed examination of the workflow under live operational conditions, but it limited the breadth of the evidence. The study did not test the workflow across projects of different scales, contractual arrangements, delivery stages, organizations, or technology environments. Project-specific characteristics may have influenced the observed outcomes. The value of the study lies primarily in its contextual depth and in the analytical relevance of its governance principles to comparable professional settings.

A second limitation concerns the retrospective baseline. The baseline was documented from recurring patterns observed across more than 200 earlier projects during 11 years of organizational practice, including five years of direct Project Manager responsibility. It was not generated through contemporaneous data collection within the same intervention project. The baseline and post-intervention evidence were not methodologically equivalent. The baseline represented recurring organizational conditions across multiple earlier projects, whereas the post-intervention evidence was recorded prospectively in one live project using the secure workflow. This difference introduces possible recall, selection, and documentation bias. The comparison supports identification of documented differences in workflow conditions, but not an experimentally controlled before-and-after measurement.

The study also did not include a parallel control project or a second organization using an alternative system. It was not possible to isolate the intervention from all other influences associated with normal project delivery. Observed differences may have been affected by project complexity, stakeholder responsiveness, decision timing, user familiarity with the workflow, or other contextual factors. The study can describe changes associated with the secure digital workflow, but it cannot establish that the intervention independently caused every observed outcome (Checkland & Holwell, 1998; Susman & Evered, 1978).

The insider practitioner-researcher position created a further limitation. The researcher designed and managed the intervention, operated in the Project Manager role, observed workflow activity, maintained reflective records, and interpreted the findings. This provided detailed contextual access, but it also created risks of confirmation bias, selective attention, and overinterpretation of improvement. The researcher's operational authority may also have influenced how other system users engaged with the workflow (Brannick & Coghlan, 2007). Structured records, predefined indicators, reflexive documentation, and evidence mapping increased transparency, but they did not remove researcher influence or provide independent external validation.

Because the structured reflective practice record was organized by Action Research phase rather than by date, the exact timing of individual reflections cannot be independently reconstructed. The record therefore supports phase-based reflexive analysis but should not be interpreted as a complete dated contemporaneous diary.

A related ethical limitation concerns authorization and participation. Appendix G provided organizational authorization for the workflow-improvement initiative and the use of anonymized process-level evidence, but it did not constitute individual informed consent, institutional ethics approval, independent validation, or permission to use personal testimony. Because the workflow operated within normal project delivery under the researcher’s Project Manager role, and system use formed part of routine organizational activity, role-coded records were treated only as evidence of documented workflow activity, not as voluntary participant testimony or evidence of user acceptance.

The study did not collect formal user-perception data. No interviews, questionnaires, focus groups, or other formal methods were used to collect the personal views of the four operational system-user roles. Statements concerning adoption, procedural difficulty, or role-specific adjustment were based on documented system activity and structured practitioner observation. They should not be interpreted as independently reported employee experiences, satisfaction ratings, psychological responses, or measured attitudes toward change.

Measurement was descriptive rather than statistical. The four indicators were categorical descriptive assessments rather than validated numerical scales. The system metrics described files, batches, roles, attachments, access rules, statuses, and recorded activity, but they did not constitute statistical measures of organizational performance. The study did not measure labor-hour savings, approval-cycle duration, productivity percentages, financial return, cost

reduction, error probability, or overall project-duration improvement. Findings concerning efficiency refer to observed improvements in coordination, searching, manual confirmation, and information retrieval rather than quantified productivity or financial gains.

The scope of accuracy was also limited. Accuracy referred to document-use accuracy: the identification, control, and use of appropriate authorized project information. The study did not evaluate the technical correctness of architectural drawings, engineering calculations, shop-drawing content, quantities, fabrication dimensions, installation quality, or physical construction outcomes. The finding that no document-related errors arising from uncontrolled version circulation were observed should not be read as evidence that all project documents were technically error-free.

The scope of cybersecurity and data protection was similarly bounded. The intervention addressed workflow-level confidentiality, document integrity, role-based access, traceability, and controlled external release. It did not constitute a comprehensive assessment of the organization's technical cybersecurity posture. The study did not examine network security, encryption strength, software vulnerabilities, malware protection, penetration testing, identity infrastructure, disaster recovery, or third-party system security. The absence of observed unauthorized access or external sharing does not show that such events were technically impossible or that every cybersecurity risk was eliminated.

The workflow system generated role-coded and timestamped records of documented activity, but these records did not capture every professional interaction. Routine telephone calls, informal discussions, external correspondence, and decisions occurring outside the system may not have been fully represented. The system records provide evidence of governed workflow activity, not a complete record of every communication or action associated with the project. Appendices B and F also contain selected or representative extracts rather than the full transaction history, while the complete operational records remain within the live system.

The study also did not examine long-term sustainability. Observation continued throughout the intervention project until formal closure on 27 February 2026, but no separate post-closure follow-up period was included. It was not possible to establish whether the observed practices would remain consistent across later projects, after personnel changes, or without the researcher's direct involvement.

Finally, the study implemented one bounded Action Research cycle. Procedural refinements occurred within that cycle, but the workflow was not subjected to a second independent cycle

of planning, implementation, observation, and reflection. The design generated evidence concerning initial implementation and operation, but it did not test how the intervention might develop through repeated cycles or through transfer into a subsequent project. The rationale for reporting one bounded cycle transparently, rather than claiming multiple cycles, is set out in Sections 2.5, 3.2, and 3.8.

These limitations require cautious interpretation of the findings. The study provides evidence that the secure digital workflow was associated with improved version clarity, approval traceability, access governance, and coordination in the documented intervention project. It does not demonstrate universal effectiveness, causal certainty, quantified financial benefit, comprehensive cybersecurity, or guaranteed performance in other settings. The methodology prioritized contextual depth and practical professional learning over experimental control and statistical breadth.

3.10. Controlled Terminology and Conceptual Boundaries

The controlled terminology applied throughout the thesis is presented in Table 1. The framework distinguishes the outcome dimensions in the research question from the evaluated indicators, improvement mechanisms, and system-status vocabularies used within the secure digital workflow.

Table 1

Controlled Terminology and Conceptual Boundaries

Term or level	Meaning and use in this thesis
Outcome dimensions	The three dimensions stated in the research question: efficiency, accuracy, and data protection. Findings are organized and interpreted in relation to these dimensions.
Four evaluated indicators	Clarity of the Latest Approved Version; Frequency of Document-Related Errors; Ease of Tracking Approvals and Revisions; and Information Governance and Data Protection Control. These labels are used consistently throughout the thesis.
Improvement mechanisms	Operational arrangements through which change was examined, including centralized information access, disciplined version control, approval traceability, role-based access control, and controlled document release. These are explanatory mechanisms, not substitute outcome dimensions.

Term or level	Meaning and use in this thesis
Efficiency	Improvement in coordination, retrieval, confirmation, and information-handling activity. It does not imply measured labor-hour savings, productivity percentages, financial return, or reduced total project duration.
Accuracy	Document-use accuracy: the identification, control, and use of appropriate authorized project information. The study does not evaluate the technical correctness of architectural drawings, engineering calculations, fabrication details, or installed work.
Document-related error	An error associated with uncontrolled document-version circulation or the use of an inappropriate document reference. It does not refer to every possible technical, design, fabrication, or construction error.
Data protection	The research-question outcome dimension concerned with protecting project information through workflow governance and release practices.
Cybersecurity	The broader professional and socio-technical domain within which the workflow controls are situated. In this study, cybersecurity claims are limited to workflow-level confidentiality, document integrity, role-based access, traceability, and controlled release.
Information governance	The organizational rules, responsibilities, classifications, permissions, and procedures governing how project information is created, accessed, approved, retained, and released.
Operational project information	Information required by the four authorized internal roles to perform project work. This includes project drawings, project and site identifiers, the project address, builder and architect details, their professional contact information, and relevant technical and coordination records. It does not include the project owner's name or personal contact information.
Project owner personal information	The project owner's name and personal contact information, including private telephone numbers, personal email addresses, and direct personal contact details. This information was not included in PUBLIC records or attachments. Confidential administration fields, where used, remained restricted to the Project Manager.
Authoritative document	A document batch promoted by the Project Manager into the controlled repository for operational use. Engineering submission alone does not make a document authoritative.

Term or level	Meaning and use in this thesis
Latest approved version	The most recent PM-promoted APPROVED drawing batch and the current authoritative operational reference. Earlier approved batches remain retained as historical approval records.
Drawing-batch status	The classification applied to a controlled drawing batch: APPROVED, HOLD, or CANCELED. In the intervention project, three drawing batches were APPROVED, one was HOLD, and none was CANCELED.
APPROVED, HOLD, and CANCELED drawing batches	APPROVED identifies a PM-promoted batch retained in the controlled repository; HOLD identifies a batch pending further review, clarification, or revision; CANCELED identifies a batch explicitly withdrawn or discontinued. APPROVED does not mean earlier approved batches are deleted or automatically reclassified when a newer approval is issued.
Pricing classification	The classification applied to pricing records: ESTIMATES, INVOICES, HOLD, or CANCELED. This vocabulary is distinct from drawing-batch status and whole-project classification.
Project classification	The whole-project lifecycle classification, such as NEW, ESTIMATING, RFP, FINISHED, ON_HOLD, or CANCELED. It applies to the project as a whole rather than to an individual document or pricing batch.
Visibility scope	The system-level visibility classification, including PUBLIC, PRIVATE_PM, and PRIVATE_SHIP. Visibility scope determines which authorized roles can access a record; PUBLIC does not mean open public or unrestricted external access. PRIVATE_PM and PRIVATE_SHIP existed as system capabilities but were not used in the intervention project; all timeline records were recorded under PUBLIC visibility.
Role-coded activity	Workflow activity attributed to a functional system role, PM, ENG, SITE, or SHIP, rather than used to assess or identify an individual employee.
System record	A role-coded, timestamped, or document-level record created or maintained through the workflow. System records provide evidence of documented platform activity but do not capture every communication or decision occurring outside it.

Term or level	Meaning and use in this thesis
Baseline	A retrospectively documented account of recurring organizational conditions across earlier projects. It is not a same-project pre-intervention measurement.
Post-intervention evidence	Prospectively recorded evidence from the one live project in which the secure digital workflow was implemented.
RECURRING	The categorical descriptor used for the retrospective baseline condition of the Frequency of Document-Related Errors indicator. It indicates that document-related errors arising from uncontrolled version circulation were identified as a recurring condition across earlier projects. It is descriptive and does not represent a statistically measured frequency or rate.
NONE OBSERVED	The categorical descriptor used for the intervention condition of the Frequency of Document-Related Errors indicator. It means that no document-related errors arising from uncontrolled version circulation were identified during the intervention observation period. It does not mean that all forms of technical, design, fabrication, or professional error were eliminated or technically impossible.
Evidence-source convergence	The comparison of complementary evidence sources within one integrated Action Research design to assess whether they support, qualify, or contradict one another. The term is used in place of formal methodological triangulation because the sources were not independent methods but components of a single practitioner-led design.
Participant or operational user	One of the four direct system-user roles involved in normal workflow activity: PM, ENG, SITE, or SHIP. The term does not imply that interviews, questionnaires, or personal-opinion data were collected.
Transferability	The conditional relevance of the study's governance principles to sufficiently comparable professional contexts. It does not mean statistical generalizability or direct replication without adaptation.
Recoverability	The Action Research quality criterion applied in this study: the intervention, evidence sources, indicators, and interpretive framework were defined before final evaluation and documented in the audit trail, so that an independent reader can trace how conclusions were reached. It does not mean that another researcher would obtain identical records or outcomes.

Where system capabilities differed from their actual use during the intervention project, the thesis distinguishes between the available function and the documented project activity.

Chapter 4: Data Analysis and Findings

4.1. Baseline Situation (Before)

This section sets out the pre-intervention conditions used as the baseline for comparison with the secure digital workflow implemented in the live project. The baseline was documented retrospectively from recurring professional practice patterns observed across more than 200 earlier projects during 11 years of organizational operation, including five years of direct responsibility in the Project Manager role (see Appendix C.1). It was not a contemporaneous pre-intervention measurement of the same project. The comparison is contextual and descriptive rather than experimentally equivalent.

The baseline accounts and indicator ratings are documented in Appendices C.1 and C.2. Appendix D provides relevant practitioner reflection, while Appendix G confirms senior organizational awareness and authorization of the improvement initiative. Appendix G is not treated as independent verification of baseline frequency or consequences. Appendix B contains selected intervention-execution records and is not a source of prior-project baseline evidence.

Before implementation, project information was managed mainly through email, shared or local folders, and direct communication between professional roles. Drawings and technical information received from consultants were stored through locally determined folder structures and manual file-naming practices. There was no formally governed project environment connecting document status, version history, approval decisions, role responsibilities, and release authority (Whyte & Lobo, 2010). As a result, identifying the current drawing, confirming approval status, and reconstructing project history depended heavily on personal awareness, searching, and manual confirmation.

Four recurring baseline patterns were identified: limited clarity of the latest approved version, document-related errors from uncontrolled version circulation, weak approval and revision traceability, and limited information-governance and data-protection control.

The first pattern concerned difficulty identifying the latest approved drawing. Multiple drawing files could exist across email threads, shared folders, and individual devices without a single authoritative operational reference. A representative incident involved the release of a non-final drawing version to a manufacturer. Stone elements were fabricated using superseded dimensional information, and the mismatch was identified during site inspection, requiring

urgent replacement delivery (see Appendix C.1, Indicator 1). This incident illustrates the possible operational consequences of version ambiguity, but it is not presented as evidence that the same consequence occurred in every earlier project. The baseline rating for Clarity of the Latest Approved Version was recorded as LOW.

The second pattern concerned document-related errors arising from uncontrolled version circulation. Several versions of a drawing could circulate simultaneously, creating a recurring risk that an outdated or inappropriate version might be used for coordination, pricing, fabrication, or site reference. This concerned document-use accuracy, not the technical correctness of drawing content. The incident above illustrates this distinction: the problem was the use of the wrong operational reference, not a proven technical design or calculation error. The baseline categorical descriptor for Frequency of Document-Related Errors was recorded as RECURRING.

The third pattern concerned weak traceability of approvals, revisions, and decision responsibility. Approval information could be distributed across meetings, telephone conversations, informal messages, or extended email exchanges without being consolidated into a structured approval record. A representative incident involved a client's selection of a stone profile during a site meeting. The selection was reflected in later shop-drawing and pricing documentation, but no sufficiently clear approval record was available when the client later disputed the selection. This limited the organization's ability to resolve the disagreement through documentary evidence. The baseline rating for Ease of Tracking Approvals and Revisions was recorded as LOW.

The fourth pattern concerned information governance and data protection. Project information was shared through email and cloud-storage arrangements without consistently defined role boundaries or controlled external-release procedures. Baseline vulnerabilities included exposure of client and property information beyond its intended boundary, insufficient segregation of supplier cost information from client-facing pricing documents, and external release of original architectural documentation. A representative incident involved architectural drawings containing client, property, and design information being sent to a manufacturer instead of organization-prepared shop drawings required for fabrication. The baseline account records this as a breach of an applicable Non-Disclosure Agreement, creating professional and reputational risk. These incidents illustrate possible consequences of weak access boundaries and release authority, not evidence that every earlier project involved a confidentiality breach.

The baseline rating for Information Governance and Data Protection Control was recorded as LOW. Table 2 summarizes the four baseline indicator ratings and their basis of assessment.

Table 2

Baseline Indicator Ratings and Basis of Assessment

Indicator	Baseline rating	Basis of assessment
Clarity of the Latest Approved Version	LOW	Identification depended on dispersed files, personal awareness, and manual confirmation.
Frequency of Document-Related Errors	RECURRING	Uncontrolled circulation created recurring risk and documented incidents involving the use of inappropriate versions.
Ease of Tracking Approvals and Revisions	LOW	Approval and revision context was distributed across informal and separate communication channels.
Information Governance and Data Protection Control	LOW	Role boundaries, information segregation, and controlled external release were not consistently formalized.

These ratings are categorical descriptions of recurring organizational conditions. They are not statistical estimates of the proportion of earlier projects affected and do not establish the precise frequency of each incident type.

The baseline problems are interpreted as weaknesses in workflow structure rather than evidence of individual professional failure (Lapointe & Rivard, 2005; Alter, 2014). Earlier arrangements could support routine delivery, but their dependence on memory, informal coordination, and dispersed storage created vulnerability as document volume, stakeholder involvement, and project complexity increased. Continuity of organization, project type, and practitioner experience supports contextual comparability with the intervention project, but it does not control for all differences in project complexity, stakeholders, timing, or operational circumstances. The baseline provides a structured professional reference point for comparison, not a same-project pre-test, controlled experimental condition, or statistically representative assessment of all earlier projects.

Together, these baseline conditions established the practical justification for introducing a governed workflow capable of distinguishing current authoritative documents, preserving approval history, controlling role-based access, and limiting external release to authorized information.

4.2. Intervention Implementation

This section explains how the secure digital workflow was implemented within the selected natural stone project. It focuses on the system configuration, operational responsibilities, document-governance procedures, implementation support, and project closure. Evaluation of the workflow conditions is presented in the later findings sections.

The intervention project commenced on 2 February 2025. The workflow was introduced from project initiation and remained in operation until formal project closure on 27 February 2026. It functioned as the governed internal environment for controlled project records, document batches, role-based activity, and authorized release. Routine communication with external stakeholders continued through existing professional channels. The specific arrangements for controlled manufacturing release and external transmission are described later in this section.

A project record was established within the digital workflow at initiation. Incoming design information, engineering submissions, pricing records, site activity, approvals, fabrication records, and delivery information were organized through eight workflow stages: Project Initiation; Design Inputs and Drawings; Engineering Outputs, including shop drawings; Pricing and Costing; Client Review and Revisions; Site Verification; Approval and Contractual Confirmation; and Manufacturing Release and Shipping. These stages provided structure while allowing the workflow to return to engineering and approval activity where an accepted change required revised documentation.

Four direct system-user roles were activated: Project Manager (PM), Engineering Team (ENG), Site Team (SITE), and Shipping Control (SHIP). The PM held full access and managed the project record, controlled drawing repository, pricing information, approval records, and authorized external release. ENG accessed the design inputs and information required for shop-drawing preparation, submitted engineering packages through the workflow, and accessed the latest approved drawing information required for continuing technical work. ENG did not have access to pricing records or fabrication and shipping records. SITE accessed the latest approved drawings and relevant coordination records required for field verification, together with read-

only access to the latest confirmed pricing summary and visibility of the latest fabrication status. SITE did not have access to full pricing history, the complete PM-controlled drawing-repository history, or the complete fabrication and shipping history. SHIP accessed the latest PM-authorized APPROVED manufacturing information and managed fabrication and delivery records, but did not have access to pricing records, contractual records, or the complete PM-controlled drawing-repository history. Operational project information published through the PUBLIC workflow was visible to all four authorized internal roles. This PUBLIC visibility provided access to recorded project activity and timeline attachments; it did not provide non-PM roles with access to the complete controlled drawing-batch history or alter the latest APPROVED drawing presented as their operational reference. The project owner's name and personal contact information were not included in PUBLIC records or attachments. The pricing and finance function remained outside the direct system-role structure; its outputs were provided to the PM through the organization's established process and then managed within the controlled pricing section.

Engineering packages were submitted through the PUBLIC project timeline. In this system, PUBLIC meant visible to authorized internal system roles, not unrestricted external or internet access. ENG submission did not automatically make a drawing authoritative. The PM reviewed submitted packages and determined whether they should be promoted into the controlled drawing repository under APPROVED or HOLD status. During the intervention project, the controlled drawing record contained three APPROVED drawing batches, one HOLD drawing batch, and no CANCELED drawing batches. Earlier APPROVED batches were retained as historical approval records and were not deleted or automatically reclassified when a later approved batch was created. The most recent PM-promoted APPROVED batch became the current authoritative operational reference.

Pricing information was managed separately from drawing-batch governance using the classifications ESTIMATES, INVOICES, HOLD, and CANCELED. During the project, the pricing record contained five INVOICES batches, one ESTIMATES batch, one HOLD batch, and one CANCELED batch. Change-control activity demonstrated the distinction between accepted and declined commercial decisions. Change Order 2 was accepted; ENG submitted revised drawings on 23 August 2025, and the PM promoted a revised APPROVED drawing batch on 25 August 2025 before further controlled release. Change Order 3 was placed on HOLD on 3 February 2026 while awaiting a client decision. Change Orders 3 and 4 were later declined, and the relevant pricing records were retained under CANCELED status on 10

February 2026. Because the declined items were not authorized for implementation, they did not initiate a new engineering revision or drawing-approval cycle.

The project timeline recorded role-coded workflow activity, contextual notes, dates, and attachments. A total of 23 timeline records were generated: 13 by PM, four by ENG, five by SITE, and one by SHIP. These records contained 107 attachments. All 23 timeline records used PUBLIC visibility within the authorized internal workflow, meaning visible to authorized internal system roles rather than unrestricted external access. PRIVATE_PM and PRIVATE_SHIP existed as system capabilities but were not used in the intervention project. Restrictions on detailed pricing, contractual records, the complete PM-controlled drawing-repository history, and the complete fabrication and shipping history were implemented primarily through dedicated role-controlled sections and 15 documented access rules. The project owner's name and personal contact information were not included in PUBLIC records or attachments.

Within the governed workflow, authoritative drawing promotion and authorization for manufacturing release remained under PM control throughout implementation. Within the documented intervention evidence, no organizational release of original architectural drawings to the manufacturer was identified. Where fabrication information was required, the PM authorized the relevant organization-prepared shop drawings from the current authoritative APPROVED drawing batch, and SHIP transmitted those authorized drawings to the manufacturer through the organization's email process. The documented evidence indicated that the manufacturer received only the approved information required for fabrication and had no direct access to the internal workflow system or the complete internal project record. Because the external transmission occurred outside the workflow platform, this finding reflects the documented workflow record together with practitioner observation rather than a complete system-generated audit of external email traffic.

After PM-controlled manufacturing release, SHIP managed fabrication and delivery tracking in the workflow. Three fabrication batches were uploaded during the intervention project, and all three were uploaded by SHIP. SHIP did not determine drawing authority or independently approve external manufacturing release; its role commenced after PM authorization.

Initial orientation was provided to the four operational roles, covering workflow stages, role responsibilities, access boundaries, submission procedures, drawing and pricing classifications, contextual-note requirements, and external-release authority. During early implementation,

additional guidance clarified version references, contextual notes, and role responsibilities. A concise internal workflow handbook was also developed to support this procedural clarification (see Appendices D and H). These actions supported adoption but did not alter the main workflow architecture, role structure, research objectives, or evaluation framework. They were procedural refinements within the single Action Research cycle, and no formal assessment of individual user performance was conducted.

The implemented workflow governed project-information handling, shop-drawing submission, pricing coordination, revision and approval records, site-verification activity, controlled manufacturing release, and fabrication and delivery tracking. It did not redesign architectural or engineering content, perform structural calculations, control the manufacturer's internal production processes, replace the organization's financial accounting system, manage the complete project schedule, alter contractual terms, or control the internal systems of clients, consultants, or manufacturers. The project remained active in the workflow until its classification was changed to FINISHED on 27 February 2026, covering approximately 13 months of live project delivery.

4.3. Post-Intervention Data

This section describes the evidence collected after the secure digital workflow was introduced into the selected natural stone project. In this study, post-intervention evidence refers to data generated prospectively while the workflow operated during live project delivery. It does not refer only to evidence collected after the project had ended.

Evidence collection began when the workflow was implemented at project initiation on 2 February 2025 and continued until formal project closure on 27 February 2026. The dataset covered approximately 13 months of project activity, including initial adoption, procedural clarification, and subsequent operation across the active workflow stages.

This section defines the nature, sources, coverage, and limitations of the post-intervention dataset. The findings derived from this evidence are presented separately in Sections 4.4 and 4.5.

The post-intervention dataset combined five complementary evidence sources used to assess workflow operation: structured practitioner observation; project and workflow documentation, including role-coded system activity; predefined categorical indicators; descriptive numerical system metrics; and reflective practitioner records (Section 3.5). These sources served different

evidential purposes. Observation, project documentation, role-coded activity, indicators, and system metrics supported analysis of workflow operation, while reflective practitioner records documented researcher learning, implementation decisions, and reflexivity. Reflective records were not used as independent confirmation of system performance or as direct evidence of the personal views of other operational users.

Structured practitioner observation was carried out by the researcher while carrying out the Project Manager role. Observation focused on workflow processes rather than individual employee performance (Coghlan & Brannick, 2014). It addressed access to current project information, engineering submission and revision practices, drawing-batch promotion and status use, approval and revision recording, role-based access behavior, controlled external release, fabrication and delivery tracking, and procedural issues arising during implementation. Where clarification was required, the action taken was recorded, including reinforcement of version-entry conventions, contextual-note requirements, and role-specific guidance. Routine professional conversations occurred during coordination and support, but these were not used as formal interviews, user-feedback sessions, or a separate participant-perception dataset.

Project and workflow documentation was generated through actual project activity. It included incoming design information, engineering submissions, controlled drawing batches, pricing batches, revision and approval records, site-verification activity, fabrication batches, delivery-tracking records, timeline entries, contextual notes, and attachments. These records enabled examination of the relationship between submissions, decisions, statuses, roles, and later project activity. They also distinguished between whole-project status, drawing-batch status, pricing classification, and visibility scope. Appendix B presents selected intervention-execution records, and Appendix F presents representative activity across the four operational roles. These appendices illustrate workflow operation but do not reproduce the complete transaction history.

Within this documentation, role-coded system activity was generated by the four direct operational system-user roles: Project Manager, Engineering Team, Site Team, and Shipping Control. Records were examined at functional-role level rather than used to identify or evaluate individual employees. The pricing and finance function contributed outputs indirectly through the Project Manager but did not hold a direct system-user role. External stakeholders were not direct research participants; where their inputs or decisions appeared in the project record, they were examined only as part of the anonymized workflow process.

Post-intervention conditions were also recorded against the four predefined indicators: Clarity of the Latest Approved Version; Frequency of Document-Related Errors; Ease of Tracking Approvals and Revisions; and Information Governance and Data Protection Control. These indicators were categorical descriptive assessments rather than numerical scales. The second indicator was limited to document-related errors arising from uncontrolled version circulation and did not assess the technical correctness of drawings, engineering calculations, fabrication details, or installation work. The indicator records are presented in Appendices C.1 and C.2, with the recorded values reported in Section 4.5.

The workflow generated descriptive numerical metrics concerning the scale and distribution of activity, including file totals, drawing-batch counts, pricing-batch counts, fabrication-batch counts, active roles, timeline records by role, attachment totals, access-rule counts, observed unauthorized access or sharing events, and final project classification. These metrics are summarized in Appendix E (System activity metrics). They describe documented system activity but are not direct measures of productivity, effectiveness, employee performance, labor savings, financial return, or project success.

The post-intervention evidence differed methodologically from the baseline. The baseline was a retrospective account of recurring conditions across earlier projects, whereas the post-intervention dataset was recorded prospectively in one live project using the secure digital workflow. The organization, project type, and practitioner setting provided contextual continuity, but the datasets were not equivalent pre-test and post-test measurements. The post-intervention data were used for structured descriptive comparison rather than experimental attribution of change.

The dataset contained contemporaneous role-coded, dated, document-level, and batch-level records, which increased traceability and reduced dependence on memory. However, the workflow was not assumed to capture every project communication. Telephone conversations, external emails, informal discussions, and decisions occurring outside the system may not have been fully recorded (Alter, 2014). The evidence supports claims about documented workflow activity and structured practitioner observation, not a complete record of every interaction associated with the project.

Research outputs were limited to anonymized roles, process-level descriptions, status records, system totals, and redacted or representative extracts. Personal names, client identity, property details, contact information, confidential pricing content, and original architectural information

were excluded from the submitted research evidence. The dataset did not include formal interviews, questionnaire responses, focus-group data, individual performance assessments, psychological measures, or independent user-satisfaction ratings.

4.4. Findings: Qualitative

This section sets out the qualitative findings derived from structured practitioner observation, project documentation, and role-coded workflow records generated during the intervention project. The findings concern observable workflow processes and documented operational behavior rather than independently reported employee perceptions. Routine professional conversations occurred during coordination and implementation support, but they were not used as a separate participant-feedback dataset. Reflective records supported interpretation of implementation experience and researcher learning, but were not used as independent confirmation of system performance.

The findings are organized according to the three outcome dimensions stated in the research question: efficiency, accuracy, and data protection. The structured indicator ratings and descriptive system metrics supporting these findings are presented separately in Section 4.5.

4.4.1. Efficiency-Related Findings

Efficiency in this study concerned coordination, information retrieval, repeated clarification, and the effort required to establish the current status of project documentation. It did not refer to measured labor-hour savings, productivity percentages, financial return, or reduction in overall project duration.

Structured observations indicated that the workflow provided a more consolidated reference point for controlled project information. Drawing submissions, authoritative batches, pricing records, site activity, fabrication records, and contextual notes were organized within defined workflow sections rather than being distributed only across email threads and separate folders. This reduced observable reliance on fragmented searching and manual confirmation when roles needed current project information.

The drawing-governance structure was especially important. ENG submitted drawing packages through the project timeline, while the PM reviewed and promoted the appropriate package into the controlled repository. Non-PM roles were directed to the latest approved drawing required for their responsibilities, while the PM retained access to the complete PM-controlled

drawing-repository history. This reduced the need to compare several files manually or repeatedly confirm which approved drawing should be used.

Contextual notes and role-coded timeline entries also supported coordination by providing a documented basis for following project activity. Users could refer to recorded submissions, updates, and attachments where these had been entered into the system, reducing dependence on separate email exchanges or personal recollection. Role-based information boundaries further focused access by directing ENG, SITE, and SHIP to the information relevant to their responsibilities rather than requiring them to navigate the complete project record.

The evidence does not show that all clarification requests, telephone calls, emails, or direct discussions were eliminated. The finding is more limited: the governed workflow reduced reliance on informal channels as the only means of locating controlled documents or understanding recorded project status. The researcher also observed reduced dependence on memory when reconstructing document status and approval history, but this should be understood as a practitioner-observed coordination pattern rather than a measured psychological reduction in cognitive load (Schön, 1983).

Overall, the qualitative efficiency finding was that centralized and role-appropriate access supported more direct retrieval of controlled information and reduced observable dependence on fragmented searching, repeated status confirmation, and informal reconstruction of project history.

4.4.2. Accuracy-Related Findings

Accuracy in this study referred to document-use accuracy: whether operational roles could identify and use the appropriate authorized project information. It did not concern the technical correctness of architectural, engineering, fabrication, or installation content.

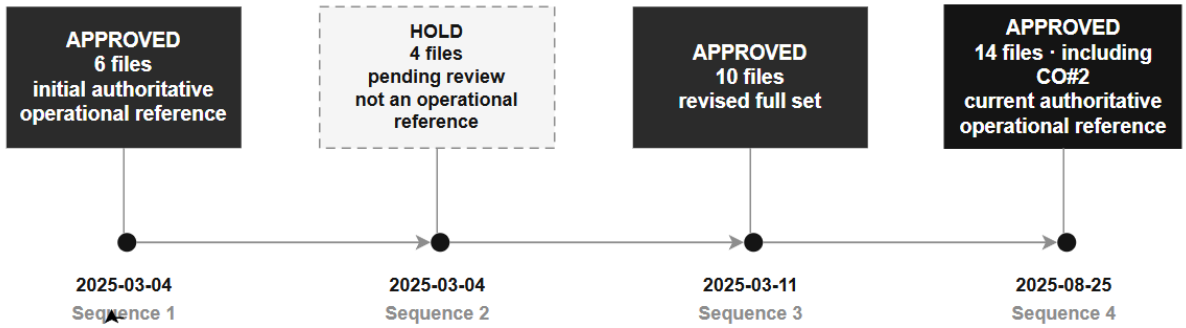
Workflow records showed that drawing updates were managed through separate submissions and controlled batches rather than by overwriting previous records. ENG submission did not automatically make a drawing package authoritative. The PM reviewed the submission and promoted the appropriate batch into the controlled repository under APPROVED or HOLD status. This created a visible boundary between a technical submission and an authoritative operational reference.

During the project, three drawing batches were retained under APPROVED status, one batch was retained under HOLD status, and no drawing batch was assigned CANCELED status (see

Appendix E, Section 1; Appendix B, Extract 4). Earlier APPROVED batches remained available to the PM as historical approval records, while the latest PM-promoted APPROVED batch served as the current authoritative operational reference. This preserved approval history while distinguishing the current approved reference from earlier approvals and material still awaiting clarification. Figure 1 presents the append-only sequence of the four drawing batches retained during the intervention project (see Appendix B, Extract 4; Appendix E, Section 1).

Figure 1

Append-Only Drawing-Batch Sequence Across the Project Lifecycle



Structured observation and project records did not identify ambiguity concerning the latest approved operational drawing during the intervention project. No document-related error arising from uncontrolled version circulation was observed during the documented period. This finding is deliberately bounded. It does not establish that every document was technically correct or that all forms of professional error were eliminated. It indicates that the baseline problem of using an inappropriate drawing because uncontrolled versions were circulating was not observed during the intervention project.

The records also demonstrated a connection between authorized commercial decisions and technical revision activity. Accepted Change Order 2 led to an ENG revised submission and subsequent PM promotion of a new APPROVED drawing batch. By contrast, Change Orders 3 and 4 were declined and remained within the pricing record; because they were not authorized for implementation, no new engineering revision or drawing-approval cycle was initiated (see Appendix E, Section 3). This supported document-use accuracy by preventing proposed or declined commercial changes from automatically altering the controlled technical record.

Some early contextual-note entries required clarification and reinforcement. These procedural lapses were retained in the evidence and addressed through additional guidance (Lapointe &

Rivard, 2005; Alter, 2014). They did not result in an observed instance of an incorrect drawing being used, but they show that effective workflow operation still depended on consistent professional input.

Overall, the qualitative accuracy finding was that the controlled distinction between submission, HOLD, historical approval, and latest authoritative approval supported consistent use of the appropriate operational document. The finding concerns governed information use, not technical verification of document content.

4.4.3. Data Protection-Related Findings

Data protection in this study concerned workflow-level confidentiality, document integrity, role-based access, traceability, and controlled external release. It did not represent a comprehensive evaluation of the organization's technical cybersecurity posture.

The workflow implemented differentiated access according to operational responsibility. The PM held full access and controlled authoritative drawing promotion, pricing records, project-level governance, and external release. ENG accessed information required for drawing preparation and submission but did not have access to pricing records or fabrication and shipping records. SITE accessed the latest approved drawing, relevant coordination information, the latest confirmed pricing summary on a read-only basis, and the latest fabrication status, but not complete pricing history, the complete PM-controlled drawing-repository history, or the complete fabrication and shipping history. SHIP accessed the latest PM-authorized APPROVED manufacturing documentation and managed fabrication and delivery-tracking records, but did not have access to pricing information, contractual records, or the complete PM-controlled drawing-repository history. Operational project information published through the PUBLIC workflow was visible to all four authorized internal roles. PUBLIC timeline visibility supported coordination and historical awareness, whereas access to the complete controlled drawing-batch history remained restricted to the PM and the latest APPROVED drawing remained the operational reference for non-PM roles. The project owner's name and personal contact information were not included in PUBLIC records or attachments (see Appendix E, Section 2).

These arrangements separated technical preparation, site use, commercial information, project authority, and fabrication tracking. They reduced reliance on individual discretion when determining which internal role should see each category of information.

All 23 timeline records used the PUBLIC visibility scope (see Appendix E, Section 1). In this system, PUBLIC meant visible to the four authorized internal operational roles and did not mean unrestricted public or external access. PRIVATE_PM and PRIVATE_SHIP existed as system capabilities but were not used during the intervention project. Restrictions concerning detailed pricing, contractual records, the complete PM-controlled drawing-repository history, and the complete fabrication and shipping history were maintained primarily through dedicated role-controlled sections and access rules.

The project records also demonstrated separation between internal project inputs and authorized manufacturing outputs. Within the documented intervention evidence, no organizational release of original architectural drawings to the manufacturer was identified. The documented evidence indicated that the manufacturer received only PM-authorized organization-prepared shop drawings from the current authoritative APPROVED drawing batch for fabrication. SHIP executed the external email transmission after PM authorization and maintained fabrication and delivery records, but did not determine drawing authority or independently authorize manufacturing release.

No unauthorized external document-sharing event and no unauthorized role-access event were observed in the documented intervention project. This indicates that the defined access and release boundaries were maintained in the available records. It does not establish that unauthorized access was technically impossible or that every communication outside the platform was captured. The absence of observed events reflects the documented workflow record and role-based configuration, not an independent technical security audit or penetration test.

Role-coded and timestamped records also supported traceability of documented workflow activity. Submissions, updates, attachments, batch records, and role actions entered through the platform could be related to the responsible functional role and date. However, the records did not provide a complete account of every informal communication or decision outside the workflow (Alter, 2014).

Overall, the qualitative data-protection finding was that role-based access, information segregation, PM-controlled external release, and role-coded records embedded governance controls into routine workflow activity. These controls were associated with maintained access and release boundaries in the documented intervention project.

4.4.4. Summary of Qualitative Findings

The qualitative evidence identified three main post-intervention patterns. First, the workflow supported efficiency by consolidating controlled information and reducing observable reliance on fragmented searching, repeated confirmation, and personal recollection. Second, it supported document-use accuracy by distinguishing technical submissions from authoritative approvals, retaining approval history, and directing operational roles to the latest approved reference. Third, it supported workflow-level data protection through differentiated access, information segregation, controlled external release, and traceable role-coded records.

These findings are based on structured practitioner observation and documented workflow activity. They do not represent independently measured employee perceptions, quantified productivity outcomes, technical drawing validation, comprehensive cybersecurity assessment, or causal proof. The corresponding categorical indicator values and descriptive system metrics are presented in Section 4.5.

4.5. Findings: Structured Descriptive Indicators and System Activity Metrics

This section sets out the structured categorical indicators and descriptive system metrics used to summarize the baseline and post-intervention workflow conditions. The indicators were not numerical scales, and the metrics were not used for inferential statistical analysis. Their purpose was to provide a transparent description of documented workflow conditions and recorded activity. Detailed indicator records are provided in Appendices C.1 and C.2, while Appendix E provides the ledger-of-record for system totals, batch structures, access rules, and activity metrics.

4.5.1. Indicator Framework and Values

Four indicators were defined before final evaluation: Clarity of the Latest Approved Version; Frequency of Document-Related Errors; Ease of Tracking Approvals and Revisions; and Information Governance and Data Protection Control. The analysis used indicator-specific categorical descriptors rather than a single numerical or ordinal scale. LOW and HIGH were used for the positively framed indicators. RECURRING and NONE OBSERVED were used for the negatively framed Frequency of Document-Related Errors indicator. LOW indicated an unsatisfactory, unclear, uncontrolled, or at-risk positive condition. HIGH indicated that the relevant positive condition was satisfactory, clear, controlled, or well managed within the

documented intervention project; it did not mean perfect or universal performance. RECURRING indicated that document-related errors arising from uncontrolled version circulation were identified as a recurring condition across the retrospective baseline. NONE OBSERVED indicated that no such error was identified during the intervention assessment period. It did not mean that all technical, design, fabrication, or professional errors had been eliminated.

The baseline and post-intervention ratings were based on different evidential conditions. The baseline was documented retrospectively from recurring patterns across earlier projects, while the post-intervention ratings were recorded prospectively in one live intervention project. The comparison is descriptive and contextual rather than an equivalent experimental pre-test and post-test. Table 3 presents the baseline and post-intervention ratings together with their recorded evidential conditions.

Table 3

Baseline and Post-Intervention Indicator Ratings and Recorded Conditions

Indicator	Baseline rating and basis	Post-intervention rating and recorded condition
Clarity of the Latest Approved Version	LOW: identification depended on dispersed files, personal awareness, and manual confirmation.	HIGH: the latest PM-promoted APPROVED drawing batch was identifiable as the current authoritative operational reference.
Frequency of Document-Related Errors	RECURRING: uncontrolled circulation created recurring risk and documented incidents involving inappropriate versions.	NONE OBSERVED: no document-related error arising from uncontrolled version circulation was identified during the intervention project.
Ease of Tracking Approvals and Revisions	LOW: approval and revision context was distributed across informal and separate communication channels.	HIGH: documented submissions, revisions, approvals, roles, and dates could be traced through the available workflow records.
Information Governance and Data Protection Control	LOW: role boundaries, information segregation, and controlled external release were not consistently formalized.	HIGH: role-based access and controlled external-release boundaries were maintained in the documented workflow, with no

Indicator	Baseline rating and basis	Post-intervention rating and recorded condition
		unauthorized access or sharing event observed.

These ratings describe documented conditions rather than statistical estimates. The version-clarity rating did not depend on earlier approved batches being deleted or classified as CANCELED. Three APPROVED drawing batches were retained as historical approval records, while the latest PM-promoted APPROVED batch served as the current operational reference. The approval-traceability rating concerned activity documented through the workflow and did not mean that every informal conversation or external communication was recorded. The data-protection rating was limited to workflow-level controls and did not represent a comprehensive technical cybersecurity assessment.

The recorded comparison is summarized visually in Figure 2 (see Table 3 and Appendices C.1 and C.2).

Figure 2

Baseline and Post-Intervention Ratings Across the Four Predefined Indicators

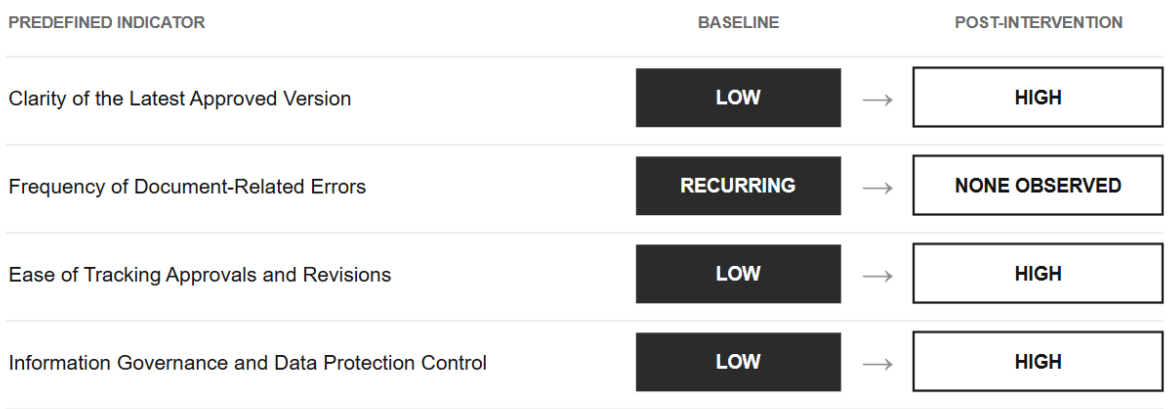


Figure 2 identifies a consistent descriptive difference between the retrospective baseline and the intervention project. It does not, by itself, establish that the workflow independently caused every observed difference. The mechanisms associated with these differences are examined in Section 4.6.

4.5.2. System Activity Metrics

In addition to the categorical indicators, the workflow generated descriptive numerical records showing the scale and distribution of documented project activity, as summarized in Table 4.

Table 4

System Activity Metrics

Metric	Recorded value
Project period	2 February 2025 to 27 February 2026
Approximate operational duration	390 days, approximately 13 months
Files in the main controlled workflow sections	73
Drawing files	34
Pricing files	36
Fabrication files	3
Drawing batches classified APPROVED	3
Drawing batches classified HOLD	1
Drawing batches classified CANCELED	0
Pricing batches classified INVOICES	5
Pricing batches classified ESTIMATES	1
Pricing batches classified HOLD	1
Pricing batches classified CANCELED	1
Fabrication batches	3
Fabrication batches uploaded by SHIP	3
Active operational system roles	4
Documented access rules	15
Timeline records	23
Timeline attachments	107
PM timeline records	13
ENG timeline records	4
SITE timeline records	5
SHIP timeline records	1
Observed unauthorized external-sharing events	0
Observed unauthorized role-access events	0
Project classification at closure	FINISHED
Closure date	27 February 2026

Note. Batch counts represent historical append-only records created across the project lifecycle. They do not represent the number of items remaining pending or active at project closure.

The 73 files comprised 34 drawing files, 36 pricing files, and 3 fabrication files. The timeline comprised 23 role-coded records with 107 attachments, and all four operational roles generated recorded activity. All 23 timeline records used the PUBLIC visibility scope, meaning visible within the authorized internal workflow rather than unrestricted external access. PRIVATE_PM and PRIVATE_SHIP existed as system capabilities but were not used in the intervention project. Restricted information was governed primarily through dedicated role-controlled sections and the 15 documented access rules.

The three fabrication batches were all uploaded by SHIP following PM-controlled manufacturing release. The zero values for observed unauthorized external sharing and unauthorized role access indicate that no such event was identified in the documented intervention evidence. They do not establish that a violation was technically impossible or that every action outside the system was observable. The absence of observed events reflects the documented workflow record and role-based configuration, not an independent technical security audit or penetration test. These metrics describe system use and governance activity; they are not direct measures of productivity, employee performance, labor savings, financial return, or project success.

4.5.3. Change Order Governance Timeline

Table 5 presents the change-order records that demonstrate the relationship between commercial decisions, engineering revisions, and drawing approval. Accepted Change Order 2 required revised technical documentation and a new authoritative drawing batch. Change Orders 3 and 4 did not proceed to implementation and were retained within the pricing record; because they were not authorized for implementation, no new engineering revision or drawing-approval cycle was initiated.

Table 5

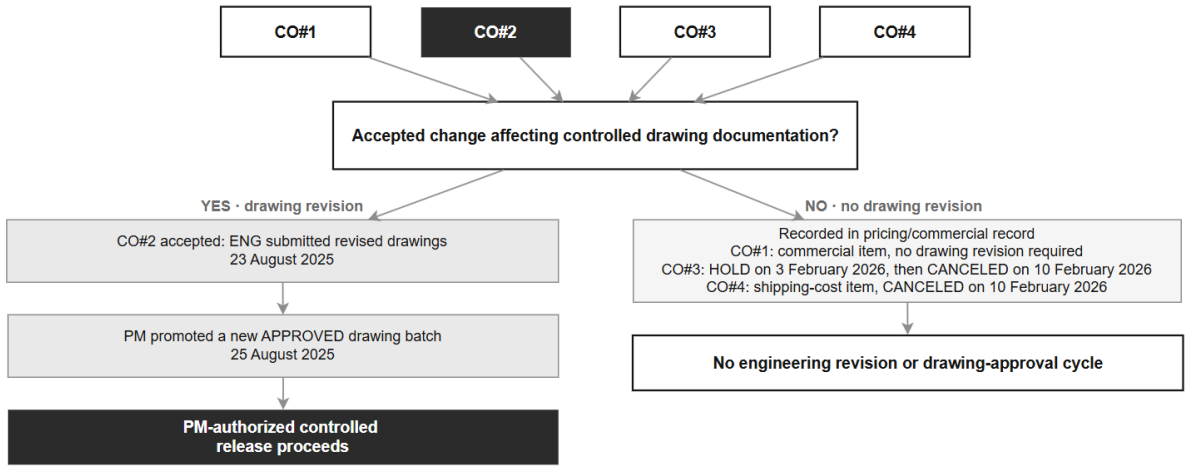
Change Order Governance Timeline

Date	Change order	Decision state	Documented workflow consequence	Evidence location
23 August 2025	CO#2	Accepted	ENG submitted revised drawings for the accepted change.	Appendix E, Section 1; Appendix F, Section 2
25 August 2025	CO#2	Accepted	PM promoted a revised authoritative APPROVED drawing batch before further controlled release.	Appendix B, Extract 4; Appendix E, Section 1
3 February 2026	CO#3	Pending	The pricing batch was placed on HOLD while awaiting the client decision. No engineering revision was initiated.	Appendix E, Section 1, latest_pricing/HOLD record
10 February 2026	CO#3 and CO#4	Declined	The declined pricing items were retained under CANCELED status. No new engineering or drawing-approval cycle was initiated.	Appendix E, Section 1, latest_pricing/CANCELED record; Appendix F, Section 2

Change-order numbering follows the organization's commercial record sequence. CO#1 related to a cost/commercial matter and did not require an engineering or drawing revision. CO#3 concerned a proposed quantity increase in one area and would have required drawing revision if accepted, but it did not proceed to implementation. CO#4 concerned an additional shipping cost for accelerated delivery and did not require a drawing revision. The records in Table 5 are those most relevant to the documented relationship between commercial decisions, engineering revisions, and drawing approvals. The sequence shows that drawing revision was linked to accepted and technically relevant change, rather than triggered by every commercial change-order item, and it also illustrates the distinction between drawing-batch status and pricing classification. Figure 3 summarizes the documented decision logic linking commercial decisions to drawing revision, drawing approval, and controlled release (see Table 5 and Appendix E, Section 1).

Figure 3

Change-Order Governance Flow: Commercial Decisions and Drawing Revision



4.5.4. Summary of Structured Findings

The categorical indicators recorded consistent descriptive changes: version clarity changed from LOW to HIGH; document-related error frequency changed from RECURRING to NONE OBSERVED; approval and revision traceability changed from LOW to HIGH; and information governance and data protection control changed from LOW to HIGH. The system metrics confirmed documented use across four roles, controlled drawing, pricing, and fabrication sections, 23 timeline records, 107 attachments, and 15 access rules. These findings provide structured evidence of the conditions recorded during the intervention project. Their interpretation, associated mechanisms, and remaining dependence on professional behavior are examined in Section 4.6.

4.6. Comparative Analysis (Before vs After)

This section compares the retrospectively documented baseline conditions with the prospectively recorded evidence from the intervention project. It draws together the qualitative findings, categorical indicators, and descriptive system metrics to explain the main differences observed in workflow coordination, document use, approval traceability, and information governance.

The comparison used the same four indicators at both reference points. However, the baseline and post-intervention evidence were not equivalent measurements of the same project. The baseline represented recurring conditions across earlier projects, while the post-intervention evidence came from one live project operating under the secure digital workflow. Continuity

of organization, project type, and practitioner context supported comparison, but did not isolate the intervention from every contextual influence. The findings identify differences associated with the workflow and the mechanisms that plausibly contributed to them; they do not establish experimental causality.

All four predefined indicators recorded a more favorable post-intervention condition than at baseline. Clarity of the latest approved version changed from LOW to HIGH. Frequency of document-related errors arising from uncontrolled version circulation changed from RECURRING to NONE OBSERVED. Ease of tracking approvals and revisions changed from LOW to HIGH. Information governance and data protection control changed from LOW to HIGH.

These differences were associated with the combined operation of system architecture, defined governance procedures, role responsibilities, orientation, and Project Manager oversight. The workflow did not simply store activity after it occurred. It structured how controlled documents were submitted, promoted, accessed, retained, and released. At the same time, its effective operation depended on users entering information correctly and following the defined process.

Version clarity and document-use accuracy improved because the workflow separated engineering submission from authoritative approval. At baseline, identifying the current drawing depended heavily on file names, email history, personal memory, and direct confirmation. Following implementation, ENG submitted drawing packages through the project timeline, while the PM determined whether each package should be promoted into the controlled repository under APPROVED or HOLD status. The latest PM-promoted APPROVED batch served as the current authoritative operational reference, while earlier approved batches remained available to the PM as historical approval records (ISO, 2018; Whyte et al., 2016). This preserved approval history without allowing older approved information to be mistaken for the current operational reference. No ambiguity concerning the latest approved operational drawing was observed, and no document-related error arising from uncontrolled version circulation was identified during the intervention project (see Appendix E, Section 1). This finding does not mean that all forms of error were eliminated; it refers only to the specific baseline problem of inappropriate document use caused by uncontrolled version circulation.

Approval and revision traceability also improved. At baseline, approval information could be distributed across meetings, telephone calls, emails, informal messages, and separate files.

During the intervention, submissions, batch promotions, status changes, contextual notes, role activity, and dates were retained in the workflow records. Change-order governance illustrated this improvement. Accepted Change Order 2 led to revised engineering documentation and PM promotion of a new APPROVED drawing batch before further controlled release. By contrast, Change Orders 3 and 4 were declined and remained within the pricing record; because they were not authorized for implementation, no new engineering revision or drawing-approval cycle was initiated (see Appendix E, Section 3). The workflow created a clearer relationship between commercial decisions, technical revision activity, and authoritative drawing approval. The resulting record improved traceability for documented workflow activity, although it did not capture every conversation or decision outside the system (Alter, 2014).

Information governance and data protection improved in the documented workflow through role-based access, information segregation, and PM-controlled external release (Sandhu et al., 1996; Saltzer & Schroeder, 1975). At baseline, project information could circulate without consistently defined access boundaries or a clear distinction between internal project inputs and authorized external outputs. Following implementation, ENG, SITE, and SHIP did not receive identical visibility across the complete project record. Operational project information was shared through the internal PUBLIC workflow. Detailed pricing, contractual records, the complete PM-controlled drawing-repository history, and the complete fabrication and shipping history were made available according to configured role rules and dedicated workflow sections. The project owner's name and personal contact information were not included in PUBLIC records or attachments. Within the documented intervention evidence, no organizational release of original architectural drawings to the manufacturer was identified. The documented evidence indicated that the manufacturer received only PM-authorized organization-prepared shop drawings from the current authoritative APPROVED drawing batch. SHIP executed the external email transmission after PM authorization and managed fabrication and delivery-tracking records, but did not determine drawing approval or independently authorize manufacturing release. No unauthorized external-sharing event and no unauthorized role-access event were observed in the documented evidence (see Appendix E; Appendix C.1, Indicator 4). This does not prove that unauthorized activity was technically impossible or that every action outside the platform was observable. The absence of observed events reflects the documented workflow record and role-based configuration, not an independent technical security audit or penetration test.

Efficiency-related differences concerned coordination rather than measured productivity. At baseline, coordination depended heavily on searching across email threads and folders, remembering document histories, and requesting confirmation of current status. The intervention consolidated controlled information within defined workflow areas and directed each role toward the information required for its responsibilities. This reduced observable reliance on fragmented searching, repeated manual confirmation, and reconstruction of project context from separate communication channels. The study did not quantify time savings, productivity gains, financial return, or reduced project duration.

Several limitations remained. The workflow did not remove dependency on accurate user input, professional judgment, PM oversight, or communication outside the system. Early incomplete contextual-note entries showed that structured fields and status rules did not fully automate information quality (Lapointe & Rivard, 2005; Adams & Sasse, 1999). Routine email, telephone, and direct communication continued, and some project context could still arise outside the workflow. The workflow also did not verify technical correctness of drawings, simplify the technical content of natural stone delivery, or assess wider cybersecurity controls such as network security, encryption, malware protection, penetration testing, disaster recovery, or third-party systems. Long-term sustainability was also outside the evidence because the workflow was observed during one project and one bounded Action Research cycle.

Overall, the comparison indicates that the intervention project operated under more structured conditions than those documented in the retrospective baseline. The secure digital workflow was associated with clearer identification of the latest approved drawing, absence of observed errors from uncontrolled version circulation, more accessible approval and revision records, maintained access and release boundaries, and reduced reliance on fragmented information retrieval. These findings support a bounded conclusion: in the documented intervention project, the workflow was associated with a shift from informal and person-dependent information handling toward more structured, traceable, and role-governed professional practice.

Chapter 5: Reflection, Professional Learning, and Implications for Practice

5.1. Reflection on the Action Research Process

This section reflects on the single bounded Action Research cycle as a source of practitioner learning (Schön, 1983; Coghlan & Brannick, 2014). It considers how the intervention was planned, implemented, observed, and reviewed within natural stone project delivery while avoiding detailed repetition of the findings presented in Chapter 4.

5.1.1. Reflection on Planning

The planning phase required the researcher to convert recurring professional problems into a defined workflow-governance issue. Difficulties with version clarity, approval traceability, fragmented retrieval, and sensitive information sharing had previously been managed mainly through experience, direct communication, and individual judgment. Planning the intervention reframed these issues as weaknesses in the structure of information governance rather than as isolated individual mistakes (Lapointe & Rivard, 2005).

A key planning lesson was that the workflow needed to be defined before the supporting technology was configured. The researcher first identified the workflow stages, role responsibilities, access boundaries, document classifications, approval authority, version rules, and external-release controls. The system was then structured around these requirements. This helped prevent the intervention from becoming another storage location and clarified that its value depended on representing professional responsibility and decision authority.

Baseline experience also influenced the emphasis on role-based access and PM-controlled external release. Prior incidents involving inappropriate information circulation showed that confidentiality could not depend only on users remembering what could be shared. Controlled access and release authority became core design features.

Implementing the intervention in one live project provided detailed evidence under real delivery conditions, but it also limited the comparison. The study did not include a same-project pre-intervention control period; comparison remained between a retrospective baseline and prospective evidence from one intervention project. In retrospect, earlier involvement of ENG, SITE, and SHIP in reviewing terminology, responsibilities, and expected entries may have reduced later clarification. This is a practical lesson for future workflow development, not proof that participatory design would necessarily have produced better outcomes.

5.1.2. Reflection on Action and Implementation

The action phase showed that the most important design decisions were governance decisions rather than technical features (ISO, 2018; Whyte & Lobo, 2010). The separation between ENG submission and PM authoritative promotion was central. ENG could submit drawing packages, but only the PM could promote a batch into the controlled repository under APPROVED or HOLD status. This clarified that submission did not automatically authorize operational or external use.

Implementation also showed the importance of separating system vocabularies. Drawing-batch status, pricing classification, project classification, and visibility scope served different purposes and could not be used interchangeably. Clarifying these terms reduced the risk that a commercial decision, technical submission, or project condition would be misunderstood.

Role-based access helped align responsibility with visibility, but access rules alone were insufficient. Users still required guidance on contextual notes, version references, status use, and role boundaries. Early procedural uncertainty was addressed through explanation, role-specific support, and an internal workflow handbook. These were refinements within the single Action Research cycle, not a second intervention or additional cycle.

Observation suggested that early difficulties were more consistent with procedural unfamiliarity than visible resistance (Lapointe & Rivard, 2005; Adams & Sasse, 1999). However, because no interviews, questionnaires, or formal attitude measures were used, this interpretation must remain cautious. The study can report observed guidance needs and role-coded system use, but not individual user perceptions.

The action phase also reinforced the continuing importance of PM oversight. The workflow did not operate autonomously. Authoritative promotion, external release, pricing governance, and procedural reinforcement remained dependent on the Project Manager. This matched the organization's structure, but it also showed that sustainability may be limited if governance remains concentrated in one practitioner without backup responsibility or wider organizational reinforcement.

5.1.3. Reflection on Observation and Evidence

Observation occurred within routine professional activity. This gave the researcher access to live workflow behavior, but it required a clear distinction between operational involvement and research interpretation.

The retrospective baseline provided detailed contextual knowledge from more than 200 earlier projects across 11 years of organizational practice, including five years of direct Project Manager responsibility (see Appendix C.1). However, it did not provide contemporaneous or statistical records for every earlier project. It was useful as a structured professional baseline, but not as an experimentally equivalent pre-test.

Post-intervention evidence was stronger in traceability because the workflow generated role-coded, dated, document-level, and batch-level records. These records supported reconstruction of documented submissions, approvals, revisions, access arrangements, and fabrication or delivery activity. However, they did not capture every telephone call, external email, informal discussion, or decision outside the platform.

The most useful analytical approach was evidence-source convergence (Lincoln & Guba, 1985). Indicator records provided the comparative structure, system records documented platform activity, practitioner observation supplied process context, and reflective records documented researcher learning. These sources were complementary, not interchangeable. The structured reflective practice record did not independently verify system performance or user perceptions; its value was to make the researcher's assumptions and decisions more visible.

Retaining implementation difficulties was also important. Early incomplete contextual notes and reinforced guidance showed that structural controls did not remove the need for professional discipline. Including these issues made the reflection more credible than presenting implementation as fully smooth.

5.1.4. Reflection on Learning and Iteration

The main learning from the cycle was that technology alone did not produce improvement. The observed changes were associated with the interaction of workflow definition, role clarity, controlled document authority, access governance, implementation support, and PM oversight. The system provided the medium, but the governance logic and professional behavior gave it practical value.

The intervention supported reduced reliance on memory and informal confirmation, but it did not eliminate human responsibility. Accurate contextual entries, appropriate submissions, PM review, and controlled release still required professional judgment. The workflow changed the structure within which professional behavior occurred; it did not replace professional behavior with automation.

The cycle generated practical lessons concerning earlier role engagement, clearer pre-implementation guidance, terminology definition, procedural review, and reduced dependence on a single governance owner. These lessons are developed into practical recommendations in Section 5.5.

Iteration in this study remained limited to clarification and procedural reinforcement. The eight-stage workflow, role model, research objectives, and indicator framework were not redesigned. A subsequent Action Research cycle would be needed to test whether the lessons learned remain effective in later projects. Overall, the process strengthened the researcher's understanding of digital workflow change as a socio-technical and organizational process shaped by system structure, governance rules, role responsibilities, implementation support, and reflective learning (Sarker et al., 2019).

5.2. Professional Learning and Development

This section examines the professional learning developed by the practitioner-researcher through designing, implementing, observing, and evaluating the secure digital workflow. The focus is on changes in professional capability, managerial judgment, change-leadership practice, reflexive awareness, and understanding of workflow-level information governance. It does not claim to measure the learning, confidence, attitudes, cybersecurity awareness, or personal experience of the other operational users. Although role-coded activity informed reflection, no interviews, questionnaires, competency assessments, or user-perception measures were conducted.

5.2.1. Development of Workflow-Governance Capability

A main area of professional development was the ability to translate complex operational activity into a governed workflow structure. Before the intervention, project coordination relied heavily on experience, direct communication, individual memory, and reactive problem-solving. These remained important, but the research showed their limits where document authority, access, approval traceability, and controlled release were not formally structured.

Designing the workflow required the researcher to examine how information moved between PM, ENG, SITE, and SHIP; where information entered the project; which role was responsible for each action; when a technical submission became authoritative; which decisions required a documented status; and who held authority for external release. This developed a clearer distinction between operational activity and workflow governance.

For example, the research clarified that an ENG submission was a technical input requiring review, while a PM-promoted APPROVED batch was an authoritative operational record. Similarly, PM authorization of manufacturing release was distinct from SHIP's execution of the external email transmission and its subsequent responsibility for fabrication and delivery tracking. This separation of responsibility, authority, status, and evidence represented an important development in managerial practice.

The intervention also developed the researcher's ability to distinguish system vocabularies. Project classification, drawing-batch status, pricing classification, and visibility scope each served different governance functions. Understanding these distinctions supported more precise communication and reduced the risk of using one status concept to represent different commercial, technical, or access conditions.

A further learning point concerned evidence-producing professional processes. The workflow was not designed only to store documents. It was designed so that submissions, promotions, approvals, role actions, dates, notes, and attachments could create a traceable record during routine work. This strengthened the researcher's understanding of evidence-based professional management. At the same time, it also produced a more cautious understanding of digital evidence: system records improved traceability, but they did not capture every telephone call, email, informal discussion, or external decision (Alter, 2014). Effective workflow governance requires both structured system design and disciplined professional documentation.

5.2.2. Development of Managerial and Change-Leadership Practice

The intervention developed the researcher's understanding of change management in a small professional organization. An initial assumption was that resistance to change might be the main implementation challenge. Observation suggested a more nuanced pattern: early difficulties appeared more closely related to procedural unfamiliarity, unclear terminology, and incomplete guidance than to visible opposition to the workflow (Lapointe & Rivard, 2005). Because no formal user-attitude data were collected, this interpretation remains cautious.

This learning changed the researcher's managerial response. Procedural lapses were not treated automatically as non-compliance. The researcher increasingly distinguished between lack of understanding, unclear instruction, unfamiliarity with the system, incomplete procedural documentation, and deliberate failure to follow a rule. This supported a shift from correction alone toward clarification, practical demonstration, and reinforcement.

Role-specific examples proved especially useful. Explaining how ENG should submit revised drawings, how SITE should identify the latest approved reference, how PM should promote the authoritative drawing batch and authorize manufacturing release, and how SHIP should transmit the authorized shop drawings and manage fabrication records was more effective than relying only on abstract system explanations.

The researcher also learned that implementation support should be prepared before workflow operation begins. The internal handbook was useful, but it was developed partly in response to uncertainty encountered during use. This learning informs the practical recommendations in Section 5.5, particularly the need for clearer pre-implementation guidance, role-specific examples, and earlier review of terminology, access, and usability issues. The study cannot prove that shared design would necessarily improve adoption, but it identifies these issues as reasonable points for future workflow improvement.

Managerial commitment remained central. The workflow did not become self-sustaining simply because it contained access rules and status classifications. The PM remained responsible for reviewing submissions, promoting authoritative batches, controlling external release, managing pricing records, and reinforcing procedures. This developed the researcher's understanding that digital transformation requires maintaining the relationship between system rules and professional practice. It also revealed a risk: concentration of governance authority in one role may limit resilience or scalability unless responsibilities are documented, shared, and supported by backup arrangements (Hobday, 2000).

5.2.3. Development of Reflexive and Evidence-Based Practice

The Action Research process strengthened the researcher's reflexive practice. As PM, the researcher designed the workflow, applied its rules, supported users, and interpreted the evidence. This provided detailed contextual knowledge but also created a risk that professional expectations or managerial authority could shape interpretation.

Structured observation and reflective records helped make this influence more visible (Finlay, 2002; Schön, 1983). Reflection required the researcher to consider how authority affected implementation, where evidence depended on interpretation, which records were generated directly by the workflow, which claims were unsupported, and which early difficulties should be retained rather than omitted.

This strengthened the distinction between professional belief and evidentially bounded conclusion. For example, reduced reliance on searching and repeated confirmation could be observed, but not converted into quantified labor savings without time data. Similarly, the absence of observed version-circulation errors could be reported, but not treated as proof that all errors were eliminated or impossible.

The researcher also developed a clearer understanding of the different functions of evidence sources. System records documented platform activity, indicator tables provided a comparative structure, practitioner observation supplied process context, and reflective records documented learning and interpretation. Recognizing these differences reduced the risk of treating reflection as independent verification or treating system records as complete representations of the whole project.

Professional learning included greater discipline in the language of claims. Terms such as "associated with," "supported," "observed," and "in the documented workflow" became important for avoiding unsupported claims of causality, elimination, or comprehensive control.

5.2.4. Professional Learning in Information Governance and Data Protection

A further area of development concerned information governance and workflow-level data protection. Before the intervention, sensitive information was protected mainly through professional discretion and expectations of appropriate conduct. Baseline experience showed that this could fail when internal information and authorized external outputs were not clearly separated.

The intervention encouraged the researcher to treat information protection as a design responsibility. This required deciding what information each role required, which records should remain restricted, how operational project information should be separated from project owner information, commercial records, and contractual records, who could access history, which documents were authorized for external release, and how release decisions should be documented.

The resulting access model clarified that not all internal users required identical information. ENG required design inputs and current technical references, but not pricing records or fabrication and shipping histories. SITE required the current approved drawing and selected operational-status information, but not complete pricing, controlled drawing-batch, or fabrication and shipping histories. SHIP required the latest PM-authorized APPROVED

manufacturing information and fabrication records, but not pricing records, contractual records, or access to the complete PM-controlled drawing-repository history. The project owner's name and personal contact information were not included in PUBLIC records or attachments. PM retained wider governance and external release responsibility.

The distinction between original architectural drawings and organization-prepared shop drawings was also professionally significant. Receiving information for internal project use did not automatically authorize its external circulation. PM-controlled release of approved shop drawings created a governance boundary between internal input and external manufacturing output.

The researcher's understanding of cybersecurity also became more precise. The study addressed confidentiality, integrity, role-based access, traceability, and controlled release in the workflow. It did not evaluate network security, encryption, authentication infrastructure, malware protection, software vulnerabilities, or penetration resistance. The learning was not that the organization had achieved comprehensive cybersecurity maturity, but that meaningful workflow-level data protection could be integrated into project practice through explicit information-governance decisions (Von Solms & Van Niekerk, 2013).

5.2.5. Overall Professional Development

The professional development arising from the study can be summarized in four areas. First, the researcher developed stronger capability in mapping operational processes and translating them into governance rules. Second, managerial practice developed from reactive correction toward clearer authority, practical demonstration, procedural support, and reflective review. Third, the research strengthened reflexive and evidence-based practice by requiring conclusions to match the available evidence. Fourth, the intervention developed a more precise understanding of information governance and workflow-level data protection as responsibilities embedded within project delivery.

These developments emerged through one bounded Action Research cycle and remain subject to further testing. They also inform the practical recommendations in Section 5.5 and the future research directions in Section 5.6.

The main professional learning was that effective digital workflow practice depends on aligning process design, authority, evidence, access, leadership, and professional behavior. Technology can support this alignment, but it does not create or sustain it independently.

5.3. Discussion of Findings in Relation to the Literature

This section discusses the study findings in relation to the literature reviewed in Chapter 2. It considers where the findings support established academic perspectives, where they provide contextual refinement, and where the evidence requires cautious interpretation. Because the study was conducted within one organization and one live project, the discussion does not claim universal confirmation of the literature. It provides context-specific evidence of how selected principles operated within natural stone project delivery.

5.3.1. Digital Transformation as Organizational and Socio-Technical Change

The findings support literature that presents digital transformation as more than the adoption of digital technology. Digital transformation involves changes in organizational processes, responsibilities, capabilities, and governance, not simply the movement of existing files into a digital environment (Vial, 2019; Matt et al., 2015).

The intervention reflected this perspective because it did not function only as a storage platform. It redefined how project information progressed through workflow stages, how engineering submission differed from authoritative approval, who controlled drawing promotion and external release, how commercial decisions related to technical revisions, and how access boundaries were applied across operational roles. The observed differences were associated with the combined operation of digital capability and organizational governance.

This refines technology-centered interpretations of digital transformation. In the study context, technological sophistication was less important than alignment between system structure and professional practice. The platform was useful because it represented defined governance requirements; it did not independently determine those requirements. At the same time, the technology was not secondary or irrelevant. It provided the practical mechanisms for role-based access, batch retention, dated records, status visibility, and controlled retrieval. The most defensible interpretation is socio-technical: workflow design, digital functionality, managerial authority, user activity, and procedural reinforcement operated together (Sarker et al., 2019).

5.3.2. Information Fragmentation, Coordination, and Efficiency

The baseline reflected problems identified in project-based work literature concerning fragmented information and distributed coordination. Project information often moves across interdependent actors, systems, and organizational boundaries, making coordination dependent on the availability, authority, and accessibility of records (Whyte & Lobo, 2010).

The study aligns with this literature by showing that dispersed storage and informal circulation increased reliance on searching, personal awareness, and direct confirmation. Under the intervention, controlled records were organized within defined workflow sections and linked to roles, statuses, notes, and attachments. This was associated with reduced observable dependence on searching across email threads and folders, manually comparing possible versions, repeatedly confirming approval status, and reconstructing project context from memory.

However, the findings do not demonstrate quantified efficiency gains. The study did not measure labor hours saved, response times, productivity rates, financial return, or reduction in total project duration. Efficiency was observed as reduced coordination and retrieval burden, not as a statistically measured productivity outcome. The findings also qualify the idea of a fully centralized project environment. External emails, telephone discussions, and direct professional communication continued. The workflow became the governed reference for controlled records, but it did not replace every communication channel used in live professional practice.

5.3.3. Document Control, Version Governance, and Accuracy

The accuracy findings support literature that treats document control as a coordination and governance function rather than a purely administrative task. Digital objects and document infrastructures can support project control only where document status, authority, and use are clearly governed (Whyte & Lobo, 2010).

The intervention provides a practice-based example of this principle. It distinguished between an ENG technical submission, a package awaiting review or clarification, a PM-promoted APPROVED batch, earlier approved historical records, and the latest authoritative operational reference. The distinction matters because digital storage alone does not resolve ambiguity. A repository may contain several technically valid documents without making clear which one is authorized for current use.

The project also showed that version history did not require earlier approved records to be deleted or reclassified as CANCELED. Three APPROVED drawing batches were retained as historical approval records, while the latest PM-promoted batch served as the current operational reference (see Appendix E, Section 1; Whyte et al., 2016). This provides a contextual refinement to simplified assumptions that only one approved version should remain visible.

The distinction between drawing status and pricing classification also contributed to workflow clarity. Accepted Change Order 2 led to a revised engineering submission and a new authoritative drawing batch. Change Orders 3 and 4 were declined and remained within the pricing record; because they were not authorized for implementation, no new engineering revision or drawing-approval cycle was initiated (see Appendix E, Section 3). This illustrates how document governance can connect commercial authority with technical change while retaining separate status vocabularies.

The finding of NONE OBSERVED for document-related errors must remain bounded. It refers only to errors arising from uncontrolled version circulation during the intervention project. It does not show that the workflow ensured technical correctness of drawings, engineering calculations, fabrication details, or installation work. The study supports the literature on version and approval governance while adding a precise distinction between document-use accuracy and technical-content accuracy.

5.3.4. Information Governance and Workflow-Level Cybersecurity

The findings also relate to literature distinguishing broad cybersecurity from information governance and information protection. Cybersecurity and information security overlap, but they are not identical (Von Solms & Van Niekerk, 2013). This distinction is relevant to the study.

The intervention addressed a bounded set of workflow-level controls: confidentiality through role-appropriate access, integrity through controlled document status and authoritative promotion, traceability through role-coded and dated records, and controlled external release under PM authority. It did not evaluate network defense, encryption, malware protection, vulnerability management, authentication infrastructure, penetration resistance, or incident-response capability. The findings concern workflow-level information governance and data protection, not comprehensive organizational cybersecurity.

The baseline incidents showed how confidentiality failures could arise through routine professional processes rather than malicious cyberattack. In particular, the release of original architectural information to a manufacturer demonstrated the risk created when internal project inputs and authorized external outputs were not clearly distinguished (see Appendix C.1, Indicator 4). The intervention addressed this by retaining original architectural drawings within the governed internal workflow and limiting external manufacturing release to PM-authorized organization-prepared shop drawings from the controlled APPROVED repository.

This supports literature that recognizes organizational roles, access practices, human activity, and supply-chain information exchange as components of information protection (ENISA, 2021; Mantha & García de Soto, 2021). However, the study cannot show that workflow controls are substitutes for technical safeguards or that governance gaps are the only cause of cybersecurity risk in SMEs. A narrower conclusion is more accurate: everyday document governance can form one practical layer of data protection within a professional SME environment.

5.3.5. Human Behavior, Adoption, and Managerial Oversight

Digital transformation literature commonly identifies leadership, organizational capability, culture, and human behavior as important implementation factors (Vial, 2019; Matt et al., 2015; Westerman et al., 2014). The findings are compatible with this literature, but they do not support strong conclusions about employee attitudes because no interviews, questionnaires, focus groups, or formal resistance measures were used.

Practitioner observation suggested that early implementation difficulties were more consistent with procedural unfamiliarity than visible opposition. Some users required clarification concerning version references, contextual notes, responsibilities, and status terminology. Practical examples and additional guidance were followed by more consistent role-coded use. This suggests that implementation difficulty should not be read automatically as resistance (Lapointe & Rivard, 2005), although the study cannot determine how users personally experienced or valued the workflow.

Managerial oversight remained central. The PM reviewed submissions, promoted authoritative batches, managed pricing information, controlled external release, and reinforced procedural expectations. This supports socio-technical perspectives in which digital systems do not operate independently of organizational authority. At the same time, concentration of authority in the PM role created a possible dependency. The study did not test operation under distributed authority, reduced PM involvement, personnel change, or larger organizational scale. Central oversight was both an implementation strength and a potential constraint on scalability.

5.3.6. SME and Natural Stone Professional Context

The study contributes to SME digital-transformation literature by providing evidence from a small, specialized, project-based professional practice (Hobday, 2000). SME transformation

depends on contextual fit, organizational capability, and proportionate adoption rather than on technology acquisition alone (Garzoni et al., 2020).

The organization did not implement a large enterprise platform. It used a context-specific system configured around its roles, document categories, approval structure, and information-governance requirements. The study does not show that a purpose-built platform is inherently superior to commercial software, shared storage, or enterprise systems. It did not compare technologies, costs, scalability, or return on investment. The transferable principle is that governance requirements should be defined before a platform is selected or configured. The appropriate technology is the one that can support necessary roles, authority boundaries, document states, release controls, and evidence requirements at a proportionate level of complexity.

The finance arrangement illustrates this contextual fit. Finance did not hold a direct system role; relevant outputs were provided to and managed by the PM. No documented access or workflow failure was identified from this arrangement during the intervention project. This should not be generalized as a preferred model for all organizations. A larger practice might require a dedicated finance role. The transferable principle is alignment between access, responsibility, and actual organizational structure.

The natural stone context also matters because the literature reviewed in Chapter 2 offered limited direct examination of this sector as an integrated setting for digital workflow governance and data protection. Natural stone project delivery combines consultant design inputs, organization-prepared shop drawings, material-specific engineering and site verification, commercial changes, external fabrication, distributed supply arrangements, confidentiality obligations, and document-dependent manufacturing release. The study makes this professional setting analytically visible and shows how general concepts such as version control, role-based access, and controlled release acquire specific meaning in this context.

The contribution should not be overstated. The findings do not establish a universal natural stone industry model or effectiveness across all specialist material sectors. They provide a detailed account of one intervention in a context that has received limited direct attention and may support analytical transfer to comparable document-intensive and externally fabricated project environments.

5.3.7. Action Research and Practice-Based Knowledge

The study aligns with Action Research literature that presents professional learning as arising through planning, action, observation, and reflection (Reason & Bradbury, 2008; Coghlan & Brannick, 2014). The intervention was developed and examined within one bounded cycle. Minor procedural refinements, additional orientation, clarification of responsibilities, and handbook development occurred within that cycle without changing the main workflow structure or evaluation framework.

This supports the value of Action Research for investigating organizational processes embedded in professional practice. The insider position enabled the researcher to identify baseline problems, implement a contextually relevant intervention, and examine detailed workflow evidence. The same position also imposed limitations because the researcher designed the system, held PM authority, supported users, and interpreted the evidence. Action Research did not remove this influence; it required it to be acknowledged and examined reflexively.

The study's contribution is practice-based rather than experimentally causal. It produced situated knowledge concerning how one workflow-governance model operated, what evidence it generated, and what challenges remained. It also demonstrates the importance of retaining qualifying evidence, including early note inconsistency, dependence on PM oversight, incomplete capture of off-system communication, and absence of long-term follow-up.

5.3.8. Overall Relationship to the Literature

Overall, the findings are broadly consistent with the literature's treatment of digital transformation as an organizational and socio-technical process. The study supports the importance of aligning technology with operational processes, defining roles and authority, controlling document status and approval, reducing fragmented retrieval, embedding access and release boundaries into workflow design, and maintaining leadership and procedural support during implementation.

The study refines these principles through context-specific evidence. It demonstrates how submission, approval, historical retention, change-order decisions, access rules, and manufacturing release can be connected in one live project workflow. It also establishes important boundaries: the findings did not quantify productivity, establish experimental causality, measure user attitudes, verify technical drawing correctness, test comprehensive cybersecurity, or prove the superiority of a specific platform.

The contribution to the literature is not the discovery of entirely new principles. It is a detailed professional account of how established principles interacted when translated into everyday practice within a specialized SME project environment. The evidence therefore supports a bounded interpretation: in the documented intervention project, digital transformation and workflow-level data protection were made operational through the combined operation of governance structures, digital capabilities, professional roles, and managerial oversight, rather than through technology adoption alone.

5.4. Limitations of the Study

This section explains how the methodological and contextual boundaries of the study affect interpretation of its findings. The methodological limitations were identified in Section 3.9; this section revisits them in light of the findings and discusses their implications for interpretation, transferability, and future use of the workflow. The limitations do not invalidate the research, but they require the findings to be understood as situated, descriptive, and practice-based evidence from one bounded Action Research intervention rather than as statistically generalizable or experimentally causal conclusions.

5.4.1. Context and Comparison

The intervention was implemented within one natural stone project in one small professional organization. This enabled detailed engagement with workflow activity under real delivery conditions, but it limited the breadth of the evidence. The findings may be relevant to comparable document-intensive SME environments involving technical coordination, external fabrication, and sensitive commercial information, but direct application to larger organizations, different sectors, or projects with more distributed authority would require adaptation and further investigation.

The comparison also had methodological limits. The baseline was retrospectively documented from recurring professional practice patterns across more than 200 earlier projects (see Appendix C.1), while the post-intervention evidence was recorded prospectively in one live project. The study did not include a same-project pre-test, a parallel control project, or inferential statistical testing. Continuity of organization, project type, and practitioner role supported contextual comparison, but it did not control for all differences in project characteristics, stakeholders, workload, timing, or operational conditions. It would be

inappropriate to attribute every observed post-intervention condition exclusively to the workflow intervention.

5.4.2. Practitioner-Researcher Position and User Evidence

The researcher designed the intervention, acted as Project Manager, supported operational users, controlled authoritative document promotion and release, observed implementation, and interpreted the evidence. This insider position provided detailed access and supported a contextually appropriate intervention, but it also created potential for researcher expectations, managerial authority, and prior experience to influence implementation and interpretation.

Structured observation, reflective records, predefined indicators, system documentation, and explicit claim boundaries were used to make this influence more visible. However, these measures did not remove researcher subjectivity or organizational power relationships. The findings should be understood as practitioner-researcher interpretation supported by documented evidence, not as independent external evaluation.

The study also did not collect formal user-perception evidence. The four operational roles used the workflow, but no interviews, questionnaires, focus groups, usability ratings, attitude measures, or competency assessments were carried out. Routine professional interaction informed coordination and reflection, but it was not used as a separate participant-feedback dataset. As a result, the study cannot establish how individual users personally experienced the workflow, whether they preferred it to previous arrangements, or whether their confidence, job satisfaction, or cybersecurity awareness changed.

5.4.3. Measurement, Accuracy, and Cybersecurity Scope

The four indicators provided a consistent structure for comparison, but they were categorical descriptive ratings rather than validated numerical measures. The study did not quantify labor hours saved, approval or response-time reductions, productivity improvement, cost savings, financial return, reduction in project duration, or the statistical frequency of errors. Changes from LOW to HIGH, or from RECURRING to NONE OBSERVED, describe indicator-specific categorical conditions within the evidence framework; they do not represent measured effect sizes.

Accuracy was examined only as document-use accuracy: the ability to identify and use the appropriate authorized information. The study did not verify the technical correctness of architectural drawings, engineering calculations, fabrication details, material specifications, or

installation work. Similarly, the cybersecurity dimension was limited to workflow-level information governance and data protection, including role-based access, information segregation, traceability, document integrity, and controlled external release. It did not assess network security, encryption, authentication strength, malware protection, software vulnerabilities, penetration resistance, incident response, backup and disaster recovery, or the cybersecurity controls of external stakeholders.

The finding that no unauthorized external-sharing or role-access event was observed should not be interpreted as proof of comprehensive cybersecurity or technical impossibility of a breach. It reflects the documented workflow record and role-based configuration, not an independent technical security audit or penetration test.

5.4.4. Completeness, Human Dependency, and Sustainability

The workflow produced contemporaneous role-coded, dated, and document-level records, but it did not capture every interaction associated with the project. External emails, telephone conversations, direct discussions, and actions outside the platform may not have been fully reflected in the system record. Appendices B and F contain selected and representative extracts rather than the complete transaction history, while full operational records remained within the live system. External assessment of the operational record is therefore limited to the submitted evidence package.

The intervention also remained dependent on professional input, PM oversight, and procedural discipline. Access rules and status classifications structured activity, but they did not ensure that every entry was complete or contextually sufficient. The PM continued to review submissions, promote authoritative batches, govern pricing information, control external release, and reinforce procedures. This concentration of responsibility may limit scalability and resilience if the model is transferred without delegation, backup responsibility, or succession planning.

The workflow was observed from 2 February 2025 to 27 February 2026, providing approximately 13 months of evidence. However, no separate post-closure follow-up period was included, and the study comprised one bounded Action Research cycle. It did not test whether the workflow would remain consistent across later projects, staff turnover, higher project volume, reduced managerial oversight, or different organizational leadership.

5.4.5. Implications for Interpretation

Taken together, these limitations require a bounded interpretation of the study. The evidence supports the conclusion that, in the documented intervention project, the secure digital workflow was associated with clearer identification of the latest approved drawing, no observed document-related error from uncontrolled version circulation, more accessible approval and revision records, maintained role-based access and controlled-release boundaries, and reduced reliance on fragmented retrieval and repeated confirmation.

The evidence does not establish that the intervention alone caused these differences, that equivalent results would occur in every project, or that the workflow provided complete technical or cybersecurity control. The study's contribution lies in providing a detailed, context-specific account of how structured workflow governance operated within one professional project. Its broader relevance rests on principled adaptation and further testing rather than direct replication.

5.5. Implications and Practical Recommendations

This section translates the findings into implications and recommendations for professional practice. The recommendations are derived from one bounded Action Research intervention and should be treated as context-sensitive governance principles rather than universally prescriptive instructions. The study does not establish that the same workflow configuration, role structure, or technology would produce equivalent outcomes in every organization. Application elsewhere would require adaptation to organizational scale, professional responsibilities, contractual arrangements, document types, project complexity, and existing digital infrastructure.

5.5.1. Implications for Professional Practice

A main implication is that project-information governance should be designed explicitly rather than left to informal professional convention. The baseline showed that experienced practitioners could maintain delivery through email, shared folders, direct communication, and personal awareness. However, these arrangements became vulnerable when multiple versions, stakeholders, decisions, and information categories had to be coordinated simultaneously.

The intervention suggests that workflow governance can be strengthened by defining the stages through which information progresses, the role responsible for each action, the distinction between submission and authoritative approval, the status of each document or commercial

item, the information accessible to each role, the authority responsible for external release, and the evidence retained for later review. Digital transformation should begin with analysis of professional authority and information flow. A technology platform should support the governance model rather than determine it without reference to actual practice (Vial, 2019; Whyte & Lobo, 2010).

A second implication concerns document authority. Central storage is not sufficient if users cannot distinguish between technical submissions, material awaiting review, historical approvals, and the current operational reference. The separation between ENG submission and PM promotion demonstrates the importance of assigning explicit authority for converting a technical package into an authoritative record. The latest approved reference should be identifiable without erasing earlier approval history (ISO, 2018; Whyte et al., 2016).

A third implication concerns role design. Access should correspond to functional responsibility rather than being uniformly open to all internal users (Sandhu et al., 1996; Saltzer & Schroeder, 1975). Role-appropriate access enabled ENG, SITE, SHIP, and PM to interact with information necessary for their responsibilities without receiving identical visibility across the full project record. The transferable principle is not the specific four-role structure, but the need to align access with operational need, decision authority, and information sensitivity.

The study also indicates the importance of a clearly identified governance owner. Within the organization studied, the PM held responsibility for authoritative document promotion, pricing governance, and external release. This reduced uncertainty, but it also created dependency. Organizations adopting a similar model should balance clear ownership with documented procedures, delegated authority where appropriate, backup responsibility, succession planning, and periodic review of role concentration.

Information governance and data protection should also be embedded in routine workflow activity, consistent with data-protection-by-design principles (European Union, 2016, Art. 25). Internal possession of information does not automatically authorize external distribution. Organizations should distinguish between information received for internal professional use, information required by specific internal roles, information approved for client or consultant review, and information authorized for fabrication or supply. This matters where original documents contain client identity, property details, commercial information, or NDA-covered material not required by an external manufacturer.

The findings also show that version governance, access control, and external release are connected responsibilities. A controlled release process must confirm both whether the recipient is authorized to receive the information and whether the released document is the correct authoritative version. These implications remain limited to workflow-level data protection. Organizations must still address technical security requirements, including authentication, backup, software maintenance, network security, malware protection, and incident response through appropriate specialist controls.

Implementation support should form part of workflow design. Early use revealed uncertainty concerning version references, contextual notes, status terminology, and role responsibilities. Practical guidance and the workflow handbook helped address these issues, but earlier preparation may have reduced the need for corrective support. Managers should also investigate why a procedure is not being followed before interpreting every lapse as resistance or negligence (Lapointe & Rivard, 2005).

Technology selection should follow definition of the governance requirement. The study does not establish that a purpose-built system is universally preferable to commercial software, shared storage, or enterprise systems. The appropriate system is the one proportionate to the organization's roles, authority boundaries, document states, access needs, release controls, evidence requirements, and reporting needs.

5.5.2. Practical Recommendations

Table 6 translates the study findings and reflective learning into practical recommendations for secure digital workflow governance.

Table 6

Practical Recommendations for Secure Digital Workflow Governance

Recommendation	Practical meaning
Map the workflow before selecting technology	Document stages, inputs, outputs, responsibilities, approval points, change-control routes, information sensitivities, and external-release requirements before configuring or purchasing a system.
Involve operational roles in design review	Ask the roles that will use the workflow to review terminology, permissions, responsibilities, and expected entries before

Recommendation	Practical meaning
	implementation. This supports shared understanding without transferring governance authority to every user.
Separate submission from authoritative approval	A submitted document should not automatically become an approved operational reference. The workflow should define who may submit, who may review, who may promote, and which version may be used operationally or externally.
Define controlled status vocabularies	Drawing status, pricing classification, project status, and visibility scope should remain separate where they represent different decisions. Users should know what each label means, who may assign it, and what consequence follows.
Retain history while identifying the current reference	Earlier approved records should remain available where they form part of approval history, but the current authoritative reference must remain clear. Historical retention should not create operational ambiguity.
Apply role-appropriate access by default	Access should be based on functional need. Organizations should review who needs current information, historical information, upload rights, approval authority, external-release authority, or restricted access to commercial, client, or technical records.
Establish explicit external-release authority	External sharing should require a defined release decision confirming the authorized document, current status, intended recipient, minimum required information, and responsible approving role.
Connect commercial decisions to technical revision	The workflow should distinguish proposed commercial changes from authorized technical changes. Accepted changes may require revised engineering documentation; pending or declined items should remain traceable without initiating a new engineering revision or drawing-approval cycle unless they are authorized for implementation.
Prepare role-specific orientation and a concise handbook	Guidance should be available from the start and should explain stages, responsibilities, status terminology, version-entry requirements, access boundaries, approval authority, and external-release procedure using realistic role-specific examples.

Recommendation	Practical meaning
Review entry quality and procedural consistency	Periodic review should examine version references, contextual notes, status accuracy, approval evidence, access appropriateness, and release records. This should support procedural improvement, not informal performance surveillance.
Reduce dependency on a single governance owner	Where several governance responsibilities are concentrated in one role, organizations should document delegated authority, backup procedures, escalation routes, and continuity arrangements.
Evaluate the workflow across later projects	A workflow should not be treated as permanently validated after one successful project. Later projects should review whether version clarity, access rules, entry discipline, governance ownership, and workflow stages remain appropriate.

5.5.3. Practical Application Boundary

These recommendations are not a fixed implementation template. The elements with the strongest potential for conditional transfer are defining the workflow before selecting technology, separating submission from authoritative approval, retaining history while identifying the current reference, aligning access with functional responsibility, controlling external release, documenting procedures, and reviewing the workflow over time.

The specific eight-stage model, four-role structure, PM authority, finance arrangement, and system architecture remain context dependent. The practical implication of the study is not that other organizations should reproduce the intervention unchanged. Rather, digital workflow improvement should be approached as the coordinated design of process, authority, information boundaries, evidence, and professional responsibility.

5.6. Future Research

The findings and limitations of this study identify several directions for future research. These directions are intended to examine the sustainability, transferability, scalability, and wider security implications of structured digital workflow governance beyond the single project and organizational setting examined in this study.

First, future research should evaluate the workflow across several projects and over a longer period. The present intervention was examined in one live project and one bounded Action Research cycle. A longitudinal and multi-project design would allow future studies to examine whether version-control discipline, role-based access, procedural consistency, and external-release controls remain effective under different project types, increased workload, repeated use, and later stages after the initial novelty of the workflow has diminished. This would help distinguish temporary implementation effects from sustained changes in professional practice.

Second, a subsequent Action Research cycle should implement and evaluate the improvements identified through reflection. These include earlier involvement of operational roles, preparation of the handbook before project initiation, more structured role-specific orientation, periodic review of contextual-note quality, delegated governance authority, and reduced dependence on the researcher as the sole operational owner. A further cycle should not simply repeat the existing intervention; it should test whether these refinements improve procedural consistency, role understanding, and organizational resilience.

Third, future research should use more methodologically equivalent comparison designs. The current study compared a retrospectively documented baseline with prospectively recorded evidence from one intervention project. Stronger future designs could include concurrent projects using different workflows, sequential projects assessed with the same prospectively defined measures, or staged implementation across comparable teams. Such designs would not remove every contextual difference, but they would provide a stronger basis for examining whether observed changes are consistently associated with the workflow intervention.

Fourth, future studies should collect formal evidence from operational users. Interviews, questionnaires, focus groups, usability studies, or structured reflective accounts could examine perceived ease of use, clarity of responsibilities, confidence in locating current information, administrative burden, views on access restrictions, attitudes toward traceability, experiences of managerial oversight, and preferences compared with earlier working arrangements. This would help determine whether practitioner-observed adoption patterns correspond with the experiences of the users themselves.

Fifth, future research should incorporate selected quantitative measures of coordination and retrieval. Possible measures include the time required to locate the current approved drawing, number of clarification requests, approval-cycle duration, repeated document transmissions, time spent reconstructing decision history, revision-related rework, administrative effort by

role, and cost consequences of document-control failures. These measures should be defined prospectively and collected consistently across comparable projects. Quantitative evidence could complement qualitative findings, while still recognizing that workflow value cannot be reduced entirely to speed or cost.

Sixth, future research should examine governance resilience beyond the original practitioner-researcher. This could include implementation led by another Project Manager, independent evaluation, transfer of approval authority to trained deputies, shared governance across more than one manager, or operation during the absence of the original system designer. Such research would help determine whether the workflow depends on the researcher's specific experience and authority or whether its governance principles can be maintained through documented organizational processes.

Seventh, future studies should test transferability across organizational scale, role configurations, sectors, and supply-chain boundaries. Larger organizations may require separate project managers, commercial managers, document-control functions, finance roles, compliance roles, multiple approval levels, or distributed access across locations. Research should also examine other document-intensive specialist sectors involving bespoke fabrication, technical submittals, confidential client information, regulated approvals, international supply chains, or external manufacturing. Including clients, consultants, manufacturers, and suppliers would extend the analysis from internal workflow governance to cross-organizational information exchange.

Eighth, future research should compare technology options and technical cybersecurity controls. The present study examined one context-specific workflow system and did not compare shared document environments, commercial workflow platforms, construction-information systems, enterprise applications, or alternative custom solutions. Future comparison should consider usability, implementation effort, permission flexibility, version and approval control, integration, scalability, maintenance, and total organizational cost. Research should also combine workflow-governance analysis with specialist cybersecurity evaluation, including authentication, encryption, network security, vulnerability management, malware protection, logging, backup and recovery, incident response, and penetration resistance.

Finally, future research could develop, refine, and evaluate a broader framework for digital workflow governance. The four indicators used in this study provided a practical descriptive

structure, but they were not validated numerical measures. A future framework could combine categorical governance indicators, quantitative workflow measures, user-perception data, technical-security measures, and project-outcome evidence. Repeated application across projects and organizations could test its reliability, sensitivity, and practical usefulness without imposing inappropriate statistical precision on complex professional settings.

Together, these directions would provide a stronger basis for assessing whether structured digital workflow governance can be sustained, adapted, scaled, and integrated with broader information-security practice across professional project environments.

5.7. Conclusion

This study examined how a secure digital workflow could support coordination efficiency, document-use accuracy, and workflow-level data protection across the natural stone project lifecycle within a professional practice context. The research question was addressed through one bounded Action Research cycle implemented during a live project from 2 February 2025 to 27 February 2026.

The evidence provides a context-specific answer. Within the documented intervention project, the secure digital workflow was associated with clearer document authority, more accessible approval and revision records, reduced reliance on fragmented information retrieval, and maintained role-based access and controlled-release boundaries. The four predefined indicators recorded descriptive movement from LOW to HIGH for clarity of the latest approved version, ease of tracking approvals and revisions, and information governance and data protection control. Frequency of document-related errors arising from uncontrolled version circulation changed from RECURRING to NONE OBSERVED. This result was limited to document-use errors caused by uncontrolled version circulation; it did not mean that all technical, engineering, fabrication, or professional errors were eliminated.

The findings suggest that these differences were associated with the combined operation of structured workflow stages, defined role responsibilities, disciplined document and status management, authoritative approval, role-appropriate access, controlled external release, implementation support, and PM oversight. The intervention operated as a socio-technical form of professional change. The digital platform provided mechanisms for records, permissions, statuses, and document histories, while organizational governance and professional behavior determined how those mechanisms were applied.

In relation to efficiency, the workflow supported reduced observable dependence on searching across fragmented locations, repeated status confirmation, and personal recollection. The study did not quantify labor savings, productivity improvement, financial return, or reduction in project duration. In relation to accuracy, the workflow supported document-use accuracy by distinguishing engineering submission from authoritative approval and directing operational roles toward the latest approved reference. It did not assess technical correctness of drawing or engineering content. In relation to data protection, the workflow embedded role-based access, information segregation, traceability, and PM-controlled external release into routine project activity. These findings concern workflow-level information governance and do not constitute a comprehensive cybersecurity assessment.

The Action Research process also generated practitioner learning. The researcher developed a more structured understanding of workflow governance, document authority, role design, evidence generation, change leadership, and the relationship between professional practice and information protection. Early implementation difficulties showed the importance of practical guidance, role-specific explanation, and procedural documentation. However, because no formal user-perception data were collected, the study cannot establish how individual users personally experienced the intervention.

The study makes three main contributions. First, it provides a practice-based account of how digital workflow governance, document control, and data protection interacted across one live project lifecycle. Second, it contributes evidence from natural stone project delivery, a specialized professional context that has received limited direct examination in the reviewed literature. Third, it shows how established governance principles can be translated into operational structures within a small project-based practice.

The conclusions remain bounded by the study design. The retrospective baseline and prospective intervention dataset were not equivalent measurements of the same project. No control project, inferential statistical analysis, independent user-perception study, technical cybersecurity assessment, or post-closure longitudinal follow-up was carried out. The researcher also designed, managed, observed, and evaluated the intervention while acting as Project Manager. The findings represent practitioner-researcher interpretation supported by structured observation and documented workflow evidence, not independent external evaluation.

The study does not claim universal generalizability or experimental causality. Its wider relevance rests on analytical and conditional transferability. Comparable organizations may find the governance principles useful, but role structures, approval authority, access arrangements, workflow stages, and technology should be adapted to their own professional context.

The study supports a bounded professional conclusion: in the intervention project, a secure digital workflow aligned with actual operational responsibilities was associated with clearer coordination, more controlled document use, stronger approval traceability, and stronger workflow-level data-protection control. The enduring contribution is not a fixed technical model for replication, but a governance principle: digital systems create professional value when they are designed around how work is authorized, documented, accessed, and controlled.

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Appendices

Appendix A: Secure Digital Workflow Structure

Natural stone project delivery: Workflow governance framework.

Project identity is anonymized to meet professional confidentiality requirements.

Section 1: Workflow Stage Structure

Table A1 presents the eight stages used by the secure digital workflow across the natural stone project lifecycle. Each stage had a responsible department, defined document types, and access limits based on the sensitivity of the information.

Terminology notes: Project classifications (NEW, ESTIMATING, RFP, FINISHED, ON_HOLD, CANCELED) describe the status of the project as a whole and are updated at major milestones. APPROVED, HOLD, and CANCELED in the drawing and pricing areas describe individual document batches. The two sets of terms work at different levels of the system.

Table A1

Secure Digital Workflow Stage Structure

Stage	Workflow stage	Department	Files/content managed	Access boundary	Status/version control
1	Project Initiation	PM	Project details, project and site identifiers, project address, builder and architect information, their professional contact information, confidential administration fields, and project notes.	Operational project information needed for internal coordination was visible to the four authorized internal roles through the PUBLIC workflow. This included the project address, builder and architect details, their professional contact information, and relevant project records. The project owner's name and personal contact information were not included in PUBLIC records or attachments. Confidential administration fields and contractual references remained restricted to the Project Manager.	Project classification tracked: NEW -> ESTIMATING -> RFP -> FINISHED / ON_HOLD / CANCELED. **Note.** The extracts in this appendix show the NEW initiation state and the FINISHED closure state. Intermediate status changes remained available in the system.
2	Design Inputs and Drawings	PM / ENG	Architectural drawings, design inputs, and reference documents received for the project.	Architectural drawings, design inputs, and technical reference documents published through the PUBLIC timeline were visible to the four	Uploaded with a timeline record. Version identifier and receipt date are logged.

Stage	Workflow stage	Department	Files/content managed	Access boundary	Status/version control
			Each file is stored with its receipt date and version reference.	authorized internal roles. PM and ENG had primary responsibility for receiving and technically processing the design inputs. Original architectural drawings remained within the authorized internal workflow as design inputs and were not designated for manufacturing release. Under the workflow design, manufacturing release was limited to PM-authorized organization-prepared shop drawings from the current authoritative APPROVED drawing batch.	
3	Engineering Outputs (Shop Drawings)	ENG	Shop drawings (PDF and DWG) with quantity and dimension data embedded in the drawing files. The Engineering team prepares these fabrication-ready documents from the design inputs.	The Engineering team prepares the package and submits it to the PUBLIC timeline. PM reviews it and promotes the authoritative batch to the controlled drawing repository for operational use.	APPROVED identifies an authorized drawing batch. The latest PM-promoted APPROVED batch is the current operational reference; earlier APPROVED batches remain retained as historical approval records. HOLD: pending review or revision. CANCELED identifies a batch explicitly withdrawn or discontinued by a documented project decision and retained for audit only.
4	Pricing and Costing	PM	Cost estimates, invoices, change orders, and payment requests. Pricing records are linked to the related drawing version.	PM has full responsibility for pricing records. Detailed pricing, pricing history, and financial documents are restricted to the Project Manager through role-based permissions. The Site team has limited read-only access to the latest confirmed pricing summary for coordination. Engineering and Shipping have no access to pricing documentation.	ESTIMATES: preliminary pricing. INVOICES: confirmed pricing. HOLD: pending client decision or approval. CANCELED: declined or withdrawn by the client, then retained for audit.
5	Client Review and Revisions	PM	Client feedback, revision instructions, updated drawing submissions, scope changes, and change order records.	PM manages client communication through existing professional channels. Resulting workflow actions and revision instructions are recorded in the timeline where applicable.	Each recorded revision cycle creates a new batch entry. Earlier batches remain as historical references. Recorded workflow actions, revision entries, status changes, and PM batch promotions include the timestamp and responsible system user.
6	Site Verification	SITE	Site measurement records, field adjustment notes, and inspection observations.	The Site team can access the latest approved drawings, site verification records, PUBLIC timeline records, the latest confirmed pricing summary on a read-only basis, and the latest fabrication status. General project information, including the project name, site address, builder and architect details, and their professional contact information, is visible when operationally required. Full pricing history, contractual references, the complete PM-controlled drawing-repository history, and the complete fabrication and shipping history are not available to the Site	Site records are logged in the timeline. Field adjustments trigger a new engineering revision when needed.

Stage	Workflow stage	Department	Files/content managed	Access boundary	Status/version control
				team. SITE can view PUBLIC timeline records and attachments, but the latest PM-promoted APPROVED drawing is presented as its operational drawing reference. The project owner's name and personal contact information are not included in PUBLIC records or attachments.	
7	Approval and Contractual Confirmation	PM	Current authoritative approved shop drawing reference.	PM confirms the current authoritative approved drawing for project use. Client and company approval communications are managed by PM outside the workflow system and are not presented as system files.	The most recent PM-promoted APPROVED drawing batch is the current authoritative operational reference. Earlier APPROVED batches remain as historical approval records and are not current operational references.
8	Manufacturing Release and Shipping	PM / SHIP	PM-authorized shop drawings from the current authoritative APPROVED drawing batch. Following PM authorization, Shipping Control transmits the authorized shop drawings to the manufacturer through the organization's email process and uploads fabrication tracking records and delivery references to the workflow system.	PM retains authority to approve and authorize manufacturing release. SHIP does not independently select or authorize a drawing package. Following PM authorization, SHIP transmits only the shop drawings from the current authoritative APPROVED drawing batch through the organization's external email process. The manufacturer has no direct access to the internal workflow system. Original architectural drawings are not included in the manufacturing transmission.	Manufacturing release uses only the most recent PM-promoted APPROVED drawing batch as the current authoritative operational reference. SHIP uploads fabrication tracking records during the delivery phases. If an accepted scope change affects controlled manufacturing documentation during the active project lifecycle, the workflow returns to Stage 3 before any further PM-authorized manufacturing transmission.

Section 2: Role-Based Access Structure

Table A2 presents the four system roles and their corresponding access boundaries. Each role controls access to specific stages, document types, and information areas. In this appendix, PUBLIC means visible to the four authorized internal roles: PM, ENG, SITE, and SHIP. It does not mean public internet access or access by manufacturers or other external parties. Records assigned PRIVATE_PM or PRIVATE_SHIP visibility are visible only to the roles authorized for that scope. During the intervention project, all timeline records used PUBLIC visibility.

Table A2

Role-Based Access Structure

Role	Role name	Workflow areas accessible	Information restricted from this role	Visibility scope
PM	Project Manager	Full access to all workflow stages. Controls external document releases and authoritative batch promotion. Manages client communication and approval records. Oversees pricing, invoicing, and contractual documentation.	No restrictions. The PM role has full project visibility by design.	PUBLIC PRIVATE_PM PRIVATE_SHIP
ENG	Engineering Team	Design inputs and received drawings. Shop drawing preparation and submission to the PUBLIC timeline. Engineering outputs and revision records. PUBLIC timeline records and attachments.	Pricing, cost estimates, invoices, contractual and financial documents, and fabrication and shipping history. The project owner's name and personal contact information are not included in PUBLIC records or attachments.	PUBLIC only
SITE	Site Team	Latest approved drawings for site reference. Site verification records. PUBLIC timeline records and attachments. Latest confirmed pricing summary, read-only. General operational project information, including the project name, site address, builder and architect details, and their professional contact information.	Pricing history and detailed financial documents. Contractual references. Complete PM-controlled drawing-repository history. Complete shipping and fabrication history. PUBLIC timeline records and attachments remain visible for authorized internal coordination but do not replace the latest APPROVED operational drawing reference. The project owner's name and personal contact information are not included in PUBLIC records or attachments.	PUBLIC, including general project information, plus latest confirmed pricing summary, read-only. **Note.** PRIVATE_PM is also available as a structural system capability for SITE, allowing access to pricing-related coordination notes if PM creates them. No PRIVATE_PM timeline records were used in this intervention project. Pricing information was handled through the dedicated PM-controlled pricing section.
SHIP	Shipping Control	Latest approved manufacturing release documents. Fabrication tracking records and delivery references. Uploading and managing fabrication tracking batches. PUBLIC timeline records and attachments, including operational project information needed for coordination.	Pricing and cost information, contractual records, the complete PM-controlled drawing-repository history, and PM-controlled administration fields. PUBLIC timeline records and attachments remain visible for authorized internal coordination, while the latest PM-authorized APPROVED shop-drawing batch is the manufacturing reference available to SHIP. The project owner's name and personal contact information are not included in PUBLIC records or attachments.	PUBLIC PRIVATE_SHIP

Section 3: Version Control Rules

Version control depends on structured upload and modification rules. Table A3 shows how the system creates new versions, retains earlier records, governs active status, and controls external release.

Table A3

Version Control Rules

Rule	Description	Application in system
Every change requires a new batch entry	Each document change is uploaded as a new batch entry in its own timestamped subdirectory. Existing batches remain in the system with their original status as historical records. CANCELED status is applied only when a batch is explicitly withdrawn or discontinued by a documented project decision. Promotion of a later APPROVED batch does not automatically change the status of an earlier APPROVED batch.	Each upload event creates a new batch stored in a timestamped folder. Earlier batches remain as historical records. If a batch is formally withdrawn or a client declines a scope item, CANCELED status is applied. In the intervention project, drawing progressions used successive APPROVED and HOLD batches. CANCELED status was used in the pricing section for change order records declined by the client.
Version identifier, date, and contextual note	Each batch entry records a version identifier, upload date, and short contextual note explaining the change. These details make the document history traceable across the project lifecycle.	**Example note** 'Rev.2: profile updated following client-approved revision request; issue date recorded in YYYY-MM-DD format.' Version identifiers, issue dates, and notes support traceability and audit across the project lifecycle.
Status governs the active version	At any point in time, the most recent PM-promoted APPROVED drawing batch is the current active operational reference. Earlier APPROVED batches remain in the repository as historical approval records and are not current operational references. HOLD batches are pending review, clarification, or revision and are not active references. CANCELED batches are retained for audit only and are not active references.	The batch status mechanism was built into the workflow platform. During the intervention project, each newly promoted APPROVED drawing batch became the current active operational reference. When a later APPROVED batch was promoted, the earlier APPROVED batch remained in the system as a historical approval record and ceased to be the current operational reference. HOLD and CANCELED batches remained visible for audit purposes but were not used as active operational references.
External release from approved version only	PM authorizes manufacturing use only from the current authoritative APPROVED drawing batch. Following that authorization, SHIP transmits the approved shop drawings to the manufacturer through the organization's email process. The workflow system does not transmit files directly, and the manufacturer has no system role or direct access. Original architectural drawings are not included in the manufacturing transmission.	The system records the current authoritative drawing batch and the subsequent fabrication and shipping tracking activity. The external email transmission itself occurs outside the workflow platform. If a later APPROVED drawing batch is promoted before any further manufacturing transmission, that later batch becomes the current authoritative operational reference. During the intervention project, SHIP uploaded three fabrication tracking batches after PM-authorized manufacturing communication.
Scope changes during the project lifecycle are managed through structured governance	If an accepted scope change affects controlled manufacturing documentation during the active project lifecycle, the workflow supports a new revision cycle beginning at Stage 3 before any further controlled release. If the client declines a proposed change order, the pricing batch is marked CANCELED and retained for audit. Declined items do not require a new engineering cycle.	A new engineering batch is prepared when required. Client approval is obtained again and recorded. A new authoritative APPROVED batch is then promoted before any further controlled release. In this intervention project, accepted Change Order 2 was incorporated through a new ENG submission and an updated APPROVED drawing batch. Later pending or declined change order items were handled through pricing HOLD and CANCELED statuses without a new engineering cycle.

This appendix records the workflow structure designed and used during the action research intervention. The system was built as a custom web application for this professional practice. Authorized roles accessed it through a browser, with no additional software installation required.

Appendix B: Workflow Execution Records (Selected Extracts)

Secure digital workflow: evidence of implementation

Project identity anonymized in line with professional confidentiality requirements.

These extracts come from system records generated during the intervention project. Each one is presented with its source, context, and relevance to the research objectives. Identifying details have been removed. The records are shown at process level so the appendix can evidence workflow behavior, traceability, and governance without exposing commercially sensitive information.

Extract 1: Project Initiation Record

Table B1 presents the project-initiation record drawn from the system timeline. It shows how the project was established in one place and how stakeholders were registered from the beginning.

Table B1

Project Initiation Record

Record type	System Event: Project Created
Department	PM: Project Manager
Timestamp	Project initiation phase: 2025-02-02
Created by	Project Manager (PM role)
Title	Project Created
System log	Project Number: [Anonymized] Classification: NEW Builder: [Anonymized construction company] Architect: [Anonymized architecture firm] Project Address: [Anonymized, residential project] Project Name: [Anonymized]
Files attached	3 files attached at initiation: • Received architectural drawings (PDF), 2 files • Project coordination communication reference (PDF), 1 file
What this shows	Shows that the project was formally opened in the system and that the operational information required by the internal project team was recorded in one centralized location. The PUBLIC record included project drawings, project and site identifiers, the project address, and builder and architect coordination information. It did not display the project owner's private telephone number, personal email address, or other direct personal contact information. Those details remained restricted to PM-controlled administration fields.

Extract 2: Engineering Drawing Submission

Table B2 presents the Engineering Team's structured drawing submission recorded in the system timeline on 3 March 2025, including contextual notes and multiple file formats.

Table B2

Engineering Drawing Submission Record

Record type	User Record: Engineering Drawing Submission
Department	ENG: Engineering Team
Timestamp	2025-03-03, following receipt of design inputs from PM
Created by	Engineering team member (ENG role)
Title	Full set shop drawings
Notes recorded	The drawing reference and revision date were documented. A technical note recorded a dimensional item and confirmed that the dimension followed the architect's specified size. A second note stated that cladding and supplementary item files were submitted for reference and would move through the HOLD mechanism in later stages. That detail matters because it captured professional judgment inside the system record rather than leaving it only in conversation or email.
Files attached	10 files submitted across the full drawing set: • Shop drawing source file (DWG format) • 3D render reference (PDF) • Cladding highlight drawing (PDF) • Cladding shop drawing (PDF) • Driveway highlight drawing (PDF) • Driveway shop drawing (PDF) • Other items highlight drawing (PDF) • Other items shop drawing (PDF) • Flatwork drawing (PDF) • Interior drawing (PDF)
What this shows	Shows that ENG submitted a structured shop drawing package through the PUBLIC timeline with a recorded revision reference, issue date, technical context, and supporting PDF and DWG files. The submission was visible to the four authorized internal roles but did not become an authoritative operational reference until PM review and promotion to the controlled drawing repository.

Extract 3: PM-Controlled Pricing Record (Selected Extract)

Table B3 presents a selected PM-controlled pricing batch record dated 4 March 2025 and demonstrates how role-based access restricted sensitive financial information.

Table B3

PM-Controlled Pricing Record: Selected Extract

Record type	File batch: pricing record (PM-controlled pricing section), selected extract
Department	PM: Project Manager
Timestamp	2025-03-04, following engineering submission
Created by	Project Manager (PM role)
Access restriction	Access to the pricing section was governed by role-based system permissions. Upload rights and full history access were restricted to the Project Manager role. The Site team had limited read-only access to the latest confirmed pricing summary for operational coordination. Engineering and Shipping had no access to pricing records.
Title	Supplier Pricing Reference
Notes recorded	Supplier pricing reference recorded. Material type and pricing category noted for internal reference.
Files illustrated	Two representative files from this batch are described here: • Supplier pricing document (PDF) • Internal cost reference (XLSX) **Note.** This extract shows two representative files from the PM-controlled pricing batch recorded on 2025-03-04. The full batch contained four files in the system ledger (see Appendix E, Section 1, latest_pricing/ESTIMATES).
What this shows	Shows that sensitive pricing information stayed inside the dedicated PM-controlled pricing section. Engineering and Shipping could not access it, and Site could see only the latest confirmed pricing summary. This directly addresses the baseline data protection issue.

Extract 4: Drawing Version Control Sequence

Source: project file batch records, drawing section. Shows the controlled drawing-batch sequence from the first PM-promoted APPROVED batch to the final PM-promoted APPROVED batch.

Table B4 shows the drawing-batch sequence recorded during the intervention project. It presents the four batches in chronological order across the project lifecycle. File names and dates have been anonymized. It presents the four drawing batches in chronological order across the project lifecycle. File names and dates have been anonymized.

Table B4

Controlled Drawing-Batch Sequence

Sequence	Stage	Status	Notes / Context	Dept	What this shows
1	Initial PM-promoted drawing batch	APPROVED	First drawing package promoted by the PM to APPROVED status (2025-03-04). Six files (5 PDF + 1 DWG). Initial authoritative operational reference established.	PM	The first APPROVED batch established the initial authoritative operational reference.
2	Supplementary drawing elements pending review	HOLD	Cladding and additional drawing elements placed on HOLD pending review (2025-03-04). Four files (4 PDF). Not active for operational reference.	PM	PM HOLD status prevented the batch from being used as an active operational reference. The batch remained retained as a historical HOLD record. Following review and engineering updates, a separate PM-promoted APPROVED batch was created as the new authoritative operational reference.
3	Revised full drawing batch	APPROVED	Full revised drawing package following consultant review and engineering updates (2025-03-11). Ten files (9 PDF + 1 DWG). This batch became the new authoritative operational reference, while the earlier APPROVED batch remained retained as a historical record.	PM	Shows structured version progression while preserving the earlier batch as a historical system record.
4	Final approved set, including Change Order 2	APPROVED	Comprehensive final package incorporating accepted Change Order 2 (2025-08-25). Fourteen files (13 PDF + 1 DWG). This final PM-promoted APPROVED batch became the current authoritative operational reference for the later fabrication phases.	PM	The complete drawing-batch sequence remained traceable across all four batches. Prior batches were preserved for audit and compliance purposes.

Extract 5: Automated Notification Record

Table B5 presents the automated notification record drawn from the system notification log and shows real-time communication and read-status accountability within the workflow.

Table B5

Automated Notification Record

Record type	System Event: Automated Notification
Trigger	New timeline record added by Engineering team member
Visibility	PUBLIC, visible to all project roles
Recipient	Project Manager notified automatically
Read status	Notification read by Project Manager within the same session
What this shows	The notification mechanism supported real-time communication across project roles. Read-status tracking helped the PM stay aware of workflow activity without depending only on informal follow-up messages, a pattern that had characterized pre-intervention coordination.

Extracts 1 to 3 and 5 were recorded by the system during live workflow activity. Extract 4 summarizes the drawing batch sequence from project file records. All project-identifying information has been removed.

Appendix C.1: Observation and Indicator Comparison Table

Secure digital workflow intervention: Retrospective baseline and post-intervention comparison

Project identity has been anonymized to meet professional confidentiality requirements.

Table C1 presents the structured comparison between the retrospectively documented baseline and the prospectively recorded intervention conditions across the four predefined indicators.

Table C1

Observation and Indicator Comparison

Indicator	Dimension	Before intervention (recurring practice across prior projects)	After intervention (system supported practice)	Observed change
Indicator 1: Clarity of the latest approved version	Ability to identify the current active version without manual clarification.	Across prior projects, drawings often sat in email threads, shared folders, and personal devices. File names were not consistent, so teams often relied on memory to decide which drawing was current. In one representative case, a drawing that was not final went to the manufacturer. The manufacturer fabricated and shipped stone elements using superseded dimensions. The mismatch appeared during site inspection, and replacement pieces had to be sent by urgent air freight. Costs increased.	During the intervention, controlled drawing batches were retained within a centralized workflow environment. Following correction of the early incomplete entries and reinforcement of orientation, drawing uploads included a version identifier, issue date, and contextual note. The current authoritative operational version was clearly identified and available to the relevant roles. Earlier batches remained as status-marked historical records, while access to the complete controlled drawing-repository history was governed by role. No version ambiguity was observed during the intervention project.	Improvement observed. No version ambiguity was observed during the intervention project, and the current authoritative operational version remained clearly identifiable.
Indicator 2: Frequency of document-related errors	Occurrence of document-use errors arising from incorrect, outdated, or insufficiently controlled document versions in active use.	Across prior projects, document updates were handled informally. No update rule was enforced. Several versions could circulate at once, with no clear way to show which version had replaced another. In the representative case above, fabrication used a superseded drawing and the problem surfaced only at site inspection. The issue came from uncontrolled file circulation, not a technical calculation error.	In the intervention project, each document change required a new batch entry with a date and note. APPROVED, HOLD, and CANCELED statuses helped separate active references from items awaiting review or withdrawn records. Access by role kept each role focused on the documents needed for its work. No document-related errors arising from uncontrolled version circulation were observed during the intervention project. Early note gaps during adoption were corrected after orientation was reinforced and did not lead to an incorrect document being used.	Improvement observed. No document-related errors arising from uncontrolled version circulation were observed during the intervention project.
Indicator 3: Ease of tracking approvals and revisions	Ability to identify the responsible system role, timestamp, recorded submission or revision	Across prior projects, approvals were often given verbally or through informal email exchanges. The organization did not keep one approval log, so decision responsibility could be difficult to confirm later. In one representative	In the intervention project, workflow records retained the responsible system role, timestamp, submission or revision action, status change, and PM batch-promotion decision. The PM could review the resulting audit trail	Improvement observed. Workflow-level approval and revision traceability was structured and auditable across

Indicator	Dimension	Before intervention (recurring practice across prior projects)	After intervention (system supported practice)	Observed change
	action, status change, PM batch-promotion decision, and the authoritative drawing version resulting from that decision.	case, a client selected a stone profile from physical samples during a site meeting. The selection appeared in the shop drawing and invoice, but the client later denied approving the change after delivery. With no formal record, the issue required extended negotiation and strained the client relationship.	and relate recorded workflow actions to the relevant document batches. Client and company approval communications remained managed separately by the PM outside the workflow system and were not presented as system-generated approval records.	the documented workflow lifecycle for recorded submissions, revisions, status changes, and PM batch-promotion decisions that established the authoritative drawing version.
Indicator 4: Information governance and data protection control	Degree of structured operational control over access to sensitive project information and data protection boundaries.	Across prior projects, files moved through email and cloud folders without defined access boundaries. Internal and external sharing followed the same informal habits. Recurring exposure patterns included client identity and property details moving beyond intended boundaries, internal supplier cost pricing being sent to clients instead of the organization's pricing submissions, and architectural documentation being shared with manufacturers. The most serious case involved full architectural drawings being sent to a stone manufacturer despite a signed NDA. These examples retrospectively illustrated recurring weaknesses in access boundaries and information-separation practice.	During the intervention, operational project information required by the four internal roles, including project drawings, the project address, builder and architect information, and their professional contact details, was shared through the internal PUBLIC workflow. The project owner's name and personal contact information were not included in PUBLIC records or attachments. Detailed pricing and pricing management functions remained with PM. SITE had read-only access only to the latest confirmed pricing summary. Contractual records and the complete controlled drawing-repository history remained restricted according to role. Within the documented intervention evidence, the manufacturer received only PM-authorized approved shop drawings, and no release of original architectural files was identified. No uncontrolled exposure of sensitive information was observed during the intervention project. External transmission to the manufacturer occurred through the organization's email process outside the workflow platform, with the PM copied on manufacturer communications. This provided managerial visibility over the external release, although the email transmission itself was not captured within the workflow platform's system-generated audit trail.	Improvement observed. The workflow separated shared operational project information from restricted administrative, commercial, and contractual information and from documentation authorized for external release.
Summary observation	Across the four indicators, the intervention project showed clearer operating records than the retrospectively documented earlier-practice baseline. Version ambiguity decreased, no document-related errors arising from uncontrolled version circulation were observed, recorded workflow submissions, revisions, status changes, and PM batch-promotion decisions became more traceable, and information governance improved through role-based access and PM-authorized external sharing. These findings support the study objectives within the limits of one professional practice and one intervention project.			

Note. Before-intervention evidence comes from recurring professional-practice patterns observed across more than 200 projects over 11 years of organizational operation, including five years in the Project Manager role, before the secure digital workflow was implemented. The incidents cited are representative examples illustrating broader recurring professional-practice patterns; they do not indicate that the same incident occurred in every earlier project or establish a measured

frequency. Post-intervention evidence comes from direct observation during the active intervention project. The comparison is descriptive and contextual and does not represent an equivalent same-project pre-test and post-test. All identifying details have been removed.

Appendix C.2: Indicator Tracking Table

Secure digital workflow intervention: retrospective baseline and post-intervention assessment

Natural stone project delivery

Project identity anonymized. The pre-intervention baseline is based on recurring practice patterns across multiple earlier projects. The four predefined indicators were evaluated using indicator-specific categorical descriptors rather than quantitative measurements. LOW and HIGH were used for the positively framed indicators, while RECURRING and NONE OBSERVED were used for the negatively framed document-error indicator. These descriptors were not points on a single numerical or ordinal scale. The baseline ratings were assigned retrospectively from recurring practitioner-observed patterns across earlier projects. The post-intervention ratings were based on evidence documented prospectively during one live intervention project. The comparison is descriptive and contextual and does not represent an equivalent experimental pre-test and post-test.

Section 1: Indicator Tracking

Table C2 records the baseline and post-intervention assessment of each predefined indicator together with its supporting evidence and interpretation.

Table C2

Indicator Tracking

#	Indicator	Dimension	Baseline condition	Baseline Rating	Post-intervention rating	Post-intervention condition	Observed change
1	Clarity of the latest approved version	Ability to identify the current active version without manual clarification	Drawing files were spread across email threads, shared folders, and individual devices. The team had no consistent naming convention. People relied on memory and ad hoc messages to identify the latest version, while several versions could circulate at once.	LOW	HIGH	During the intervention, controlled drawing batches were retained within a centralized workflow environment. Following correction of the early incomplete entries and reinforcement of orientation, drawing uploads included a version identifier, issue date, and contextual note. The current authoritative operational version was clearly identified and available to the relevant roles. Earlier batches remained as status-marked historical records, while access to the complete controlled drawing-repository history was governed by	Improvement observed. No version ambiguity was observed during the intervention project, and the current authoritative operational version remained clearly identifiable.

#	Indicator	Dimension	Baseline condition	Baseline Rating	Post-intervention rating	Post-intervention condition	Observed change
						role. No version ambiguity was observed during the intervention project.	
2	Frequency of document-related errors	Occurrence of document-use errors arising from incorrect, outdated, or insufficiently controlled document versions in active use	Informal document handling had no enforced update rule. Several versions could circulate without a clear supersession mechanism. In a representative incident, fabrication proceeded from a superseded drawing, causing an on-site mismatch and urgent air freight costs.	RECURRING	NONE OBSERVED	Each change required a new batch entry with a date and notes. The APPROVED / HOLD / CANCELED status mechanism supported active-version control. No document-related errors arising from uncontrolled version circulation were observed during the intervention project. Early incomplete note entries were corrected after orientation reinforcement and did not lead to incorrect document use.	Improvement observed. No document-related errors from uncontrolled version circulation were observed during the intervention project.
3	Ease of tracking approvals and revisions	Ability to identify the responsible system role, timestamp, recorded submission or revision action, status change, PM batch-promotion decision, and the authoritative drawing version resulting from that decision.	Approvals were communicated verbally or through informal email. No structured approval log was maintained. In a representative incident, a client denied approving a profile change selected during a site meeting. With no formal record, the dispute required extended negotiation.	LOW	HIGH	Workflow records retained the responsible system role, timestamp, submission or revision action, status change, and PM batch-promotion decision. The PM could access a structured audit trail linking recorded workflow actions to the relevant document batches. Client and company approval communications remained outside the workflow system and were not presented as system-generated approval records.	Improvement observed. Workflow-level approval and revision traceability was structured and auditable across the documented workflow lifecycle for recorded submissions, revisions, status changes, and PM batch-promotion decisions that established the authoritative drawing version.
4	Information governance and data protection control	Degree of structured operational control over access to sensitive project information and data protection boundaries	Files were shared by email and cloud folders without defined access boundaries. Internal and external sharing protocols were not separated. In a representative incident, full architectural drawings were sent to the manufacturer in error, breaching a signed NDA and creating reputational risk that required formal remediation.	LOW	HIGH	Operational project information required by the four internal roles, including project drawings, the project address, builder and architect information, and their professional contact details, was shared through the internal PUBLIC workflow. The project owner's name and personal contact information were not included in PUBLIC records or attachments. Detailed pricing records were restricted to PM. SITE had read-only access only to the latest confirmed pricing summary. Contractual records and the complete controlled drawing-repository history remained restricted according to role. Within the documented intervention evidence, the manufacturer received only PM-authorized approved shop drawings, and no release of	Improvement observed. The workflow separated shared operational project information from restricted administrative, commercial, and contractual information and from documentation authorized for external release.

#	Indicator	Dimension	Baseline condition	Baseline Rating	Post-intervention rating	Post-intervention condition	Observed change
						original architectural files was identified. No uncontrolled exposure of sensitive information was observed during the intervention project. External transmission to the manufacturer occurred through the organization's email process outside the workflow platform, with the PM copied on manufacturer communications. This provided managerial visibility over the external release, although the email transmission itself was not captured within the workflow platform's system-generated audit trail.	

Note. The pre-intervention baseline comes from recurring practice patterns observed across multiple projects over an extended period of organizational operation. The incidents cited are representative examples. Post-intervention evidence comes from direct observation during the active intervention project. The two evidence sources were not methodologically equivalent. Identifying details have been removed.

Summary. The four indicators improved after the secure digital workflow was implemented. The clearest changes appeared in workflow clarity, document control, approval and revision traceability, and information governance. These findings remain bounded to the single-project intervention. No document-related errors arising from uncontrolled version circulation were observed during the intervention project. Role-based access and PM-authorized external sharing supported more disciplined information governance. Table C3 defines the indicator-specific categorical descriptors used in the assessment.

Table C3

Indicator-Specific Categorical Descriptor Definitions

Descriptor	Definition
LOW	For positively framed indicators, the condition was unsatisfactory: unclear, uncontrolled, or at risk.
HIGH	For positively framed indicators, the condition was satisfactory: clear, controlled, or well managed within the documented intervention project.
RECURRING	Document-related errors arising from uncontrolled version circulation were identified as a recurring baseline condition across earlier projects. This descriptor does not represent a statistically measured frequency or rate.
NONE OBSERVED	No document-related errors arising from uncontrolled version circulation were identified during the intervention assessment period. This does not mean that all forms of technical, design, fabrication, or professional error were eliminated.

Section 2: Observation Log

Table C4 presents the structured observation records covering retrospectively documented baseline patterns from earlier projects and prospectively recorded observations from the intervention project.

Table C4

Observation Log

#	Phase	Department	Indicator ref.	Observation	Assessment
1	Baseline (prior projects)	PM / ENG / SITE	Indicators 1 and 2	Drawing files were distributed across email threads, shared cloud folders, and individual workstations. No consistent naming convention was applied. Version identification depended on individual memory and ad hoc communication between team members.	Version ambiguity was retrospectively identified as a recurring professional-practice condition across earlier projects, creating a continuing risk of outdated document use.
2	Baseline (prior projects)	PM	Indicator 3	Approval records were not maintained in a structured log. Decisions were communicated verbally or through informal email threads. Retrospective approval checks were unreliable without extensive email searching.	Weak approval traceability was retrospectively documented as a recurring professional-practice condition across earlier projects.
3	Baseline (prior projects)	PM / ENG	Indicator 4	Sensitive project files, including pricing, client identity, and architectural drawings, were shared without defined access boundaries. File distribution did not follow role-based restrictions.	Data-protection risks and recurring patterns of uncontrolled information exposure were retrospectively identified across earlier projects. Representative incidents illustrated the operational and confidentiality consequences of these patterns.
4	Post-intervention (intervention project)	PM / ENG / SITE / SHIP	Indicator 1	After the early incomplete entries were corrected through orientation reinforcement, drawing uploads included a version identifier, issue date, and contextual note. All drawing versions were retained in the centralized workspace, and no ambiguity was observed regarding the current authoritative operational reference throughout the remaining project lifecycle.	Version clarity: HIGH. No version ambiguity was observed during the intervention project.
5	Post-intervention (intervention project)	PM / ENG	Indicator 2	No document-related errors arising from uncontrolled version circulation were observed during the intervention project. The batch status mechanism kept the most recent PM-promoted APPROVED drawing batch as the current active operational reference. Earlier APPROVED batches remained as historical approval records and were not used as current operational references. Early incomplete note entries were identified and corrected through targeted orientation reinforcement, and no incorrect document was accessed or used as a result.	Document errors: NONE OBSERVED during the intervention project.
6	Post-intervention (intervention project)	PM	Indicator 3	Workflow records retained the responsible system role, timestamp, submission or revision action, status change, and PM batch-promotion decision. The PM could access the resulting audit trail and relate recorded workflow actions to the relevant document batches. Client and company approval communications remained outside the workflow system and were not presented as system-generated approval records.	Workflow-level approval and revision traceability: HIGH. A structured audit trail was maintained for recorded system actions across the documented workflow lifecycle.

#	Phase	Department	Indicator ref.	Observation	Assessment
7	Post-intervention (intervention project)	PM / ENG / SITE / SHIP	Indicator 4	Operational project information needed by the four internal roles, including project drawings, the project address, builder and architect information, and their professional contact details, was available through the internal PUBLIC workflow. The project owner's name and personal contact information were not included in PUBLIC records or attachments. Detailed pricing and pricing management functions were restricted to PM. SITE had read-only access only to the latest confirmed pricing summary. Contractual records and the complete controlled drawing-repository history remained restricted according to role. Within the documented intervention evidence, the manufacturer received only PM-authorized approved shop drawings, and no release of original architectural files was identified. No uncontrolled exposure of sensitive information was observed during the intervention project. External transmission to the manufacturer occurred through the organization's email process outside the workflow platform, with the PM copied on manufacturer communications. This provided managerial visibility over the external release, although the email transmission itself was not captured within the workflow platform's system-generated audit trail.	Information governance and data protection: HIGH. The workflow separated shared operational project information from restricted administrative, commercial, and contractual information and supported PM-authorized external release.
8	Post-intervention (intervention project)	ENG / SITE / SHIP	Implementation observation	The practitioner-researcher observed that the Engineering team required less orientation and integrated the workflow into routine use more quickly. The Site team required additional practical orientation and took longer to integrate the workflow into daily practice. Shipping Control used the workflow consistently once its role-specific responsibilities were clarified.	Recorded workflow use and the level of orientation required varied across roles. Differences in prior exposure to structured digital work and daily task context were considered possible explanations for this variation, while targeted role-specific orientation was followed by more consistent use. These explanations were not independently assessed through interviews, questionnaires, or competency measures.

The researcher recorded observations during routine project work. No identifying personal data, contractual content, pricing values, or other commercially sensitive details were reproduced in the research observation record. Observations were anonymized at process and functional-role level in line with professional confidentiality requirements.

Section 3: Summary Dashboard

Table C5 summarizes the recorded results across the four predefined indicators.

Table C5

Summary Dashboard of Indicator Results

Indicator	Baseline Rating	Post-Intervention Rating	Key change observed
Clarity of the latest approved version	LOW	HIGH	Version ambiguity was substantially reduced through the structured workflow. Following correction of the early incomplete entries, the current authoritative operational version remained clearly identifiable across the documented intervention workflow.
Frequency of document-related errors	RECURRING	NONE OBSERVED	No document-related errors from uncontrolled version circulation were observed during the intervention project. Early note-level lapses were corrected through orientation without affecting document accuracy.
Ease of tracking approvals and revisions	LOW	HIGH	A structured audit trail was established across workflow stages. Recorded workflow actions retained the responsible role and timestamp, while contextual notes were generally included; early incomplete note entries were identified and corrected through targeted orientation.
Information governance and data protection control	LOW	HIGH	The workflow separated shared operational project information from restricted administrative, commercial, and contractual information. Role-based controls were maintained within the workflow, while PM-authorized external release was supported by the documented workflow record and practitioner observation.

Overall conclusion: All four indicators improved after implementation. The evidence remains bounded to one SME professional practice and one intervention project. Within that scope, the findings suggest that structured workflow governance, disciplined version control, and role-based access can improve day-to-day coordination and information governance.

Table C6 aligns the structured findings with the research question and its three outcome dimensions.

Table C6

Research Question Alignment and Findings Summary

Research Question Alignment	How can a secure digital workflow improve efficiency, accuracy, and data protection across the natural stone project lifecycle within a professional practice context?
Efficiency Finding	Reduced document search effort, fewer clarification loops, and clearer task progression were observed under centralized information access.
Accuracy Finding	Consistent reference to the latest active version and reduced informal document handling were observed, supported by traceable recorded submission and revision actions, status changes, and PM batch-promotion decisions across the documented workflow lifecycle.
Data Protection Finding	Access boundaries were maintained within the workflow, and the documented evidence supported PM-authorized external release of approved documentation, strengthening operational control over information integrity and confidentiality.

Appendix D: Structured Reflective Practice Record

Action Research Intervention: Professional Reflection and Positionality

Project identity anonymized in line with professional confidentiality requirements.

This appendix presents the researcher's structured reflective practice record for the Action Research intervention. The record is organized around the four-part Action Research cycle: planning, action, observation, and reflection. The final section addresses reflection, learning, and iteration, and the record is organized by phase rather than by date. Appendix D is the only separate reflective evidence document used for Objective 3. No separate dated diary or additional reflective file exists. Each entry records what happened, how the researcher interpreted the relevant events and decisions, and what was learned. The purpose is to show the professional judgment behind the intervention, including implementation difficulties and limits of interpretation, rather than to defend the outcome.

Reflective Entry 1: Planning Phase

Table D1 records the planning-phase decisions made before the intervention began and the reasoning behind the workflow design.

Table D1

Planning Phase Reflective Record

AR phase	What happened	Reflection	Professional learning
Planning	The secure digital workflow was introduced at the start of a new project. Before any project activity began, the workflow stages were set out and linked to the roles that would use them.	The main concern was not the technology. It was whether the team would use the workflow consistently once project pressure started. Previous experience had shown that digital tools without a clear process tend to be used unevenly or abandoned. For that reason, the design stayed simple. Each role, including the site team, had to understand what to do and why it mattered.	Digital transformation planning works best when the process matches real work. A clear purpose at the start reduced the need for correction later in the project lifecycle.
Planning	Access boundaries were defined before the project started instead of being added later after problems appeared. Detailed pricing, project owner personal information, and external release of original architectural drawings were treated as restricted from the outset.	This decision came from repeated problems in earlier projects. Sensitive information, including full architectural drawings, had sometimes been shared externally without enough control, creating confidentiality risks. The planning phase turned those lessons into rules: original architectural drawings would stay internal, and only organization-prepared shop drawings would be released for fabrication.	Professional experience, including past failures, can be a valid input to research design. Building lessons into the workflow was more reliable than depending on individual awareness alone.

Reflective Entry 2: Action and Implementation Phase

Table D2 records how the workflow was introduced to the operational roles and how early implementation and adoption were managed.

Table D2

Action and Implementation Phase Reflective Record

AR phase	What happened	Reflection	Professional learning
Action	The main observed implementation difficulty involved unfamiliarity with the system and uncertainty about the required procedure. Several team members were new to the system and hesitated to use it independently. Some early entries were incomplete, with missing version notes or issue dates.	The observed behavior appeared more consistent with unfamiliarity with the system and procedural uncertainty than with active resistance. Early incomplete entries and requests for additional guidance indicated uncertainty about the platform and the expected procedure. Engineering adapted quickly and had earlier experience with structured digital work. The Site team required additional orientation, while Shipping Control used the workflow more consistently once its role-specific responsibilities were clarified. These observations supported a cautious interpretation of the visible adoption difficulties, but the study did not collect direct evidence of users' attitudes or motivations.	Observed adoption difficulties should be interpreted cautiously before being classified as resistance. In this intervention, practical demonstration and role-specific support appeared more effective than enforcement or broad written instructions.
Action	The hardest decision was to explain the system to each team separately instead of issuing one general instruction. This took significant time during an active delivery period.	The decision added short-term pressure to project delivery. Earlier professional experience suggested that general instructions were often misunderstood when teams had different levels of digital experience. The Site team required practical demonstration rather than written guidance alone. In this intervention, role-specific engagement was followed by more consistent workflow use.	Early role-specific managerial support appeared to reduce the need for repeated procedural correction during this intervention.

Reflective Entry 3: Observation Phase

Table D3 records the observations that became visible as the workflow settled into routine professional use.

Table D3

Observation Phase Reflective Record

AR phase	What happened	Reflection	Professional learning
Observation	After the initial orientation period, workflow use became more consistent across the teams. Version entries included identifiers, dates, and notes. No document-related errors arising from uncontrolled version circulation were observed	From the researcher's operational perspective, the workflow appeared to reduce the coordination burden associated with searching for the current drawing, checking approval status, and following up on messages. This was interpreted as reduced reliance on fragmented retrieval and repeated confirmation,	Fragmented workflow can create an observable coordination burden. In this study, efficiency should be interpreted through documented retrieval and confirmation practices rather than assumed improvements in psychological well-being or quantified productivity.

AR phase	What happened	Reflection	Professional learning
	during the intervention project. Pricing records remained in the PM-controlled pricing section throughout the project.	not as a measured psychological outcome or independently reported user experience.	
Observation	Engineering required less orientation and integrated the workflow into routine use more quickly. The Site team required the most practical support and took longer to integrate the workflow into daily practice. Shipping Control used the workflow consistently once its responsibilities were clarified. The Project Manager maintained oversight and procedural reinforcement throughout.	The different rates of integration appeared consistent with differences in role context and prior exposure to structured digital work. Engineering routinely worked with version-controlled files and structured submissions, while the Site role was primarily field based and required more practical demonstration. Shipping Control's focused task scope may also have supported consistent use once the interface and responsibilities were explained. These were practitioner interpretations of the observed implementation pattern rather than independently measured user characteristics or motivations.	Workflow implementation should account for differences in role context, prior exposure to structured digital work, and the level of practical orientation required. In this intervention, role-specific guidance was followed by more consistent workflow use than the initial general approach.

Reflective Entry 4: Reflection, Learning, and Iteration Phase

Table D4 records the end-of-cycle reflection, professional learning, and changes proposed for a future implementation.

Table D4

Reflection, Learning, and Iteration Phase Reflective Record

AR phase	What happened	Reflection	Professional learning
Reflection, Learning, and Iteration	Minor adjustments were made during the project to clarify responsibilities and improve usability. The core workflow logic did not change. A short internal workflow handbook was produced and shared with all teams during early adoption (see Appendix H). Some teams adopted the workflow faster than others because prior digital experience differed by role.	In a future implementation, all teams should be involved in workflow design before system decisions are finalized. Early involvement in defining stages, responsibilities, and access needs would likely build ownership and reduce orientation effort. In this project, the researcher designed the workflow and then introduced it to the teams. A more participatory approach would likely have strengthened commitment and behavior alignment from the start. The handbook was useful, but it filled a gap that earlier involvement might have prevented.	Early stakeholder involvement is a design tool, not just consultation. When teams help shape a process, they understand it more deeply and follow it more consistently. A handbook is still useful, but it works best when it records decisions that teams helped make.
Reflection, Learning, and Iteration	The end-of-period evaluation was positive. All four indicators showed observable improvement. The workflow continued to operate consistently following the initial orientation and procedural clarification period.	The strongest professional lesson was that the old workflow did not fail because technology was missing. Technology was already there. What was missing was structure. Once the method was clear, with defined stages, roles, and operating rules, a straightforward digital platform could work as a governance tool. This reinforced the view that digital transformation in professional practice is mainly organizational and behavioral, not only technical.	Technology enables. Methodology governs. Both are needed, but methodology should come before technology decisions. This lesson should guide future workflow improvements within the organization and in comparable practice settings.

Retrospective positionality statement

The following statement is a retrospective reflexive synthesis prepared for the submitted record. It is not presented as a contemporaneous dated entry.

The researcher operated simultaneously as Project Manager and practitioner-researcher. This dual role provided direct access to the workflow, enabled implementation decisions, and allowed operational difficulties to be addressed quickly. It also created a risk that managerial authority, commitment to the intervention, and familiarity with the project could influence both user behavior and the researcher's interpretation of improvement.

Because the study did not collect interviews, anonymous feedback, or an independent user-perception dataset, it was not possible to determine whether consistent workflow use reflected practical acceptance, managerial expectation, or a combination of both. Role-coded activity showed that the workflow was used, but it did not provide direct evidence of users' personal agreement, satisfaction, or motivation.

Predefined indicators, system-generated records, retained implementation difficulties, and the separation of reflective interpretation from system evidence reduced reliance on personal judgment but did not remove insider influence. Future evaluation should involve operational roles earlier in workflow design and, where feasible, include independent or anonymous user feedback.

Reflective Summary: Key Themes and Professional Implications

Table D5 summarizes the main reflective themes and their implications for professional practice.

Table D5

Reflective Themes and Professional Implications

Reflective theme	Key insight	Professional implication
Adoption challenge	The observed adoption difficulties appeared more consistent with unfamiliarity with the system and procedural uncertainty than with active resistance. Workflow use became more consistent after practical explanation and role-specific support, although the study did not collect direct evidence of users' attitudes or motivations.	Distinguish observed procedural difficulty from inferred resistance before responding. Practical, role-specific demonstration appeared more effective than enforcement or abstract written instructions in this intervention.
Hardest decision	Orienting each team personally took time during an active project and appeared to support more consistent workflow use.	Early managerial engagement may reduce later correction, but this was a practice-based inference rather than a measured comparison of time or cost.
What would be done differently	In a future implementation, the operational teams would be involved earlier in reviewing workflow terminology, responsibilities, access boundaries, and expected entries before final system decisions were made. Earlier structured involvement could have supported clearer role understanding and reduced implementation	Early stakeholder involvement can function as part of workflow design rather than consultation alone. Participatory review may support clearer role understanding and more sustainable workflow integration, although this was not tested independently in the present study.

	friction. The handbook was useful, but it addressed a clarification need that earlier engagement might have reduced.	
Shipping Control role	Shipping Control used the workflow consistently once its role in PM-authorized manufacturer communication and fabrication and delivery tracking was clarified. The bounded SHIP interface appeared to support focused integration and required less continuing orientation than roles with broader or less familiar workflow responsibilities.	Clear role scope can support workflow integration. In this intervention, defined SHIP functions and role-specific orientation were associated with consistent use once access and responsibility boundaries were understood.
Researcher positionality and authority	The combined PM and practitioner-researcher role enabled direct implementation and observation but may also have influenced user behavior and the interpretation of improvement. The available evidence could not distinguish fully between practical acceptance and response to managerial expectations.	Future evaluations should include earlier user participation and, where feasible, independent or anonymous feedback. Documented workflow use should not be treated as direct evidence of personal acceptance.
Central learning	The main limitation of the previous workflow was not the absence of digital technology but the absence of a defined governance structure. Once the workflow method, responsibilities, document states, and access boundaries were established, the digital platform provided an effective means of applying those controls within the intervention project.	Digital transformation should be approached first as an organizational and governance challenge. Workflow methodology should guide technology decisions rather than follow them. This principle may be relevant to comparable document-intensive professional contexts, subject to contextual adaptation and further evaluation.

This appendix is the only separate structured reflective evidence document used for the Action Research intervention. It is organized by phase rather than by date, and no separate dated diary or additional reflective file exists. It documents implementation difficulties, professional decisions, learning, and a clearly labeled retrospective positionality statement. It does not provide independent evidence of other users' perceptions or independent verification of system performance.

Appendix E: System Evidence

Secure digital workflow: Technical and structural evidence of implementation

Project identity anonymized. File names have been replaced with anonymized identifiers. Dates and timestamps are retained to show workflow chronology, sequencing, and audit traceability.

This appendix sets out the system evidence for the secure digital workflow. The workflow operated in a live professional project from 2 February 2025 to 27 February 2026, approximately 13 months. The appendix contains three types of evidence: the file storage structure generated by the system, the role-based access control rules taken from the implemented platform, and a mapping table linking each research claim to the relevant system record.

The timestamps and file records were generated automatically during live project work. They show activity across the project lifecycle and all four system roles, from project initiation to project closure. Appendix F maps representative multi-role activity explicitly to the eight workflow stages.

Section 1: Actual File Storage Structure

The structure below shows the real folder and file organization generated during the intervention project. Each batch was stored in its own archived timestamped subdirectory under the relevant status folder. File names have been replaced with anonymized identifiers, while file types (PDF, DWG, XLSX, JPG, and PNG) are retained as evidence of document type and workflow activity.

```
Project folder: PN-[Anonymized]/
├── latest_drawing/
│   └── PM/
│       ├── APPROVED/
│       │   ├── [Batch 1 - 2025-03-04 18:03]  →  6 files  (5 PDF + 1 DWG)
│       │   ├── [Batch 2 - 2025-03-11 11:55]  →  10 files (9 PDF + 1 DWG)
│       │   └── [Batch 3 - 2025-08-25 10:14]  →  14 files (13 PDF + 1 DWG)
│       ├── HOLD/
│       │   └── [Batch 2025-03-04 18:04]    →  4 files  (4 PDF)
│       └── CANCELED/
│           (no canceled drawing batches recorded during the intervention)
│
├── latest_pricing/
│   └── PM/                          ← PM-controlled; SITE: latest summary read-only
│       ├── INVOICES/
│       │   ├── [Batch 1 - 2025-03-11 11:54]  →  4 files  (4 PDF)
│       │   ├── [Batch 2 - 2025-04-02 12:32]  →  5 files  (5 PDF)
│       │   ├── [Batch 3 - 2025-04-26 12:35]  →  6 files  (6 PDF)
│       │   ├── [Batch 4 - 2025-08-25 10:15]  →  7 files  (7 PDF)
│       │   └── [Batch 5 - 2026-02-10 14:25]  →  7 files  (7 PDF)
│       ├── ESTIMATES/
│       │   └── [Batch 2025-03-04 18:05]    →  4 files  (2 PDF + 2 XLSX)
│       ├── HOLD/
│       │   └── [Batch 2026-02-03 19:09]    →  1 file   (1 PDF)  [CO#3 pending]
│       └── CANCELED/
│           └── [Batch 2026-02-10 14:26]    →  2 files  (2 PDF)  [CO#3 & CO#4 declined]
│
├── latest_fabrication/
│   └── SHIP/                        ← Uploaded by SHIP role; PM oversight
│       ├── [Batch 1 - 2025-11-25 14:58]        →  1 file  (1 XLSX) [Phase 1 arrived]
│       ├── [Batch 2 - 2026-01-26 10:11]        →  1 file  (1 XLSX) [Phase 2 arrived]
│       └── [Batch 3 - 2026-02-26 17:18]        →  1 file  (1 XLSX) [Balance arrived]
│
└── timeline/
    ├── PM/    ← PUBLIC records (13 records: 2025-02-02 to 2026-02-27)
    │   ├── [2025-02-02 17:47]  →  3 files (PDF)        Project initiation
    │   ├── [2025-02-18 17:51]  →  4 files (JPG)        Notes from meeting
    │   ├── [2025-02-20 17:53]  →  4 files (JPG)        Notes from meeting
    │   ├── [2025-02-28 17:54]  →  8 files (JPG)        Notes from meeting
    │   ├── [2025-03-07 18:08]  →  2 files (PDF)        Interior blueprints
    │   ├── [2025-03-10 09:49]  →  1 file  (PDF)        Note from architect
    │   └── [2025-03-25 16:57]  →  2 files (PDF + PNG)  Rendering from architect
    │  [+ 6 further coordination records with low or no attachment volume,
    │   retained in the live system, see note below]
    │
    ├── ENG/   ← PUBLIC records (4 records: 2025-03-03 to 2025-08-23)
    │   ├── [2025-03-03 17:57]  →  10 files (9 PDF + 1 DWG)
    │   ├── [2025-03-11 10:04]  →   3 files (2 PDF + 1 DWG)
    │   ├── [2025-04-02 10:05]  →  13 files (12 PDF + 1 DWG)
    │   └── [2025-08-23 12:06]  →  14 files (13 PDF + 1 DWG)
    │
    ├── SITE/  ← PUBLIC records (5 records: 2025-03-13 to 2026-02-27)
    │   ├── [2025-03-13 10:14]  →   2 files (JPG)
    │   ├── [2025-03-18 15:02]  →   3 files (JPG)
    │   ├── [2025-03-25 14:02]  →  31 files (JPG)  Field measurement photos
    │   ├── [2025-08-20 17:50]  →   6 files (JPG + PNG)
    │   └── [2026-02-27 16:40]  →   0 files        Site confirmation record
    │
    └── SHIP/  ← PUBLIC records (1 record: 2026-02-26)
        └── [2026-02-26 17:19]  →   0 files        Items arrived notification
Total files in main workflow sections: 73  (34 drawing | 36 pricing | 3 fabrication)
Project duration: 2025-02-02 to 2026-02-27  (approximately 13 months)
```

Note on timeline display: To keep the structure readable, only selected dated entries with attachments are shown above. The complete internal timeline contains 23 records (PM: 13 | ENG: 4 | SITE: 5 | SHIP: 1) and 107 attachments. Of the six PM timeline entries not listed individually, one contained a single attachment and the other five contained no attachments. All six remain in the live system and are included in the 23-record and 107-attachment totals.

The structure shows three controls working in practice: timestamped batch folders for each upload event, status classification through APPROVED / HOLD / CANCELED folders, and role-based separation through PM, ENG, and SHIP storage paths. During the intervention project, the drawing, pricing, and fabrication sections held 73 files in total.

The project timeline records operational activity, submissions, coordination events, and historical workflow actions across the project lifecycle. The latest_drawing directory had a narrower function. It retained PM-authorized APPROVED drawing batches in separate timestamped folders. At any point in time, the most recent PM-promoted APPROVED batch served as the current active operational reference, while earlier APPROVED batches remained as historical approval records. This structure supported controlled access and prevented earlier approved information from being mistaken for the current operational reference.

System Activity Metrics

Table E1 summarizes the operational records drawn directly from the workflow system during the intervention project.

Table E1

System Activity and File-Storage Metrics

Metric	Value
Total files in main workflow sections (drawing, pricing, fabrication)	73
Operational project duration	2 February 2025 to 27 February 2026, approximately 13 months
Drawing batches: APPROVED	3
Drawing batches: HOLD	1
Drawing batches: CANCELED	0
Pricing batches: INVOICES	5
Pricing batches: ESTIMATES	1
Pricing batches: HOLD (CO#3 pending client decision)	1
Pricing batches: CANCELED (CO#3 and CO#4 declined by client)	1
Fabrication / shipping tracking batches uploaded by SHIP role	3
Active system roles engaged across the project lifecycle	4
Total timeline records across all roles	23 (PM: 13 | ENG: 4 | SITE: 5 | SHIP: 1)
Total timeline attachments	107

Metric	Value
Observed instances of unauthorized external document sharing within the documented intervention evidence	0
Observed instances of unauthorized role access	0
Project classification at closure	FINISHED (confirmed 2026-02-27)

External email transmission to the manufacturer occurred outside the workflow platform. Therefore, the reported value reflects the documented intervention evidence and practitioner observation rather than a complete system-generated audit of external email traffic.

Section 2: Role-Based Access Control Rules

Table E2 documents the role-based access rules and operational responsibility boundaries used in the workflow platform. Checkmarks identify the roles authorized to perform each action under the documented workflow rules. Each rule is shown with its representative technical enforcement condition or documented operational role basis.

Note on drawing submission terminology: In this table, “Promote drawing batch to latest_drawing/” refers to the PM action that creates an official APPROVED or HOLD batch in the controlled drawing repository. This differs from the Engineering team’s submission of drawing packages through PUBLIC timeline records for PM review. Both actions form part of the workflow, but only a PM-promoted APPROVED batch establishes the authoritative operational drawing version used by the relevant roles. A HOLD batch remains retained in the controlled repository as a pending-review record and is not used as the active operational reference.

Note on PRIVATE_PM and PRIVATE_SHIP visibility scopes: These scopes existed as structural governance capabilities in the system. During the intervention project, all 23 timeline records used PUBLIC visibility and were visible to the four authorized internal roles. PUBLIC did not mean public internet access or access by external users. The project owner’s name and personal contact information were not included in PUBLIC records or attachments. Detailed pricing records and pricing-management functions remained under PM control, while SITE had read-only access only to the latest confirmed pricing summary. Confidential administrative fields remained accessible only to PM. The scope names are system-level technical identifiers rather than literal descriptions of exclusive access. PRIVATE_PM permits access to PM and SITE, while PRIVATE_SHIP permits access to PM and SHIP.

Table E2

Role-Based Access Control Rules

Action / area	PM	ENG	SITE	SHIP	Enforcement basis
Edit project administration fields	✓	✗	✗	✗	$canEditProject = ($roleCode === 'PM')
Add PUBLIC timeline record with role-relevant notes and supporting attachments	✓	✓	✓	✓	$canAddTimeline = (!$isLocked || $roleCode === 'PM')
Submit an engineering-issued drawing package to the PUBLIC timeline for PM review	✓	✓	✗	✗	Operational role rule: all roles may upload supporting attachments, but engineering-issued drawing packages are submitted by ENG or PM. Authoritative promotion remains technically restricted to PM.
Promote drawing batch to the controlled drawing repository (APPROVED or HOLD status)	✓	✗	✗	✗	$canUploadDrawing = ($roleCode === 'PM')
View latest approved drawing	✓	✓	✓	✓	$canSeeDrawingLatest = true
View drawing history and all drawing batches	✓	✗	✗	✗	$canSeeDrawingHistory = ($roleCode === 'PM')
Upload pricing batches	✓	✗	✗	✗	$canUploadPricing = ($roleCode === 'PM')
View latest confirmed pricing summary	✓	✗	✓	✗	$canSeePricingLatest = ($roleCode === 'PM' || $roleCode === 'SITE')
View pricing history and full pricing documentation	✓	✗	✗	✗	$canSeePricingHistory = ($roleCode === 'PM')
Upload fabrication tracking batches	✓	✗	✗	✓	$canUploadFabrication = ($roleCode === 'PM') || ($roleCode === 'SHIP' && !$isLocked) In this project, all three fabrication batches were uploaded by SHIP.
View latest fabrication and shipping status	✓	✗	✓	✓	$canSeeFabricationLatest = PM || SITE || SHIP
View fabrication and shipping history	✓	✗	✗	✓	$canSeeFabricationHistory = PM || SHIP
See PUBLIC timeline records	✓	✓	✓	✓	visibility_scope = 'PUBLIC'
See PRIVATE_PM timeline records (coordination notes, not used in this project)	✓	✗	✓	✗	PRIVATE_PM: PM and SITE only
See PRIVATE_SHIP timeline records (shipping-only records, not used in this project)	✓	✗	✗	✓	PRIVATE_SHIP: PM and SHIP only

Note. Access-control clarification: PUBLIC timeline visibility and controlled drawing-repository access were separate functions. All four authorized internal roles could view PUBLIC timeline records and attachments. PM alone could access the complete controlled drawing-batch history, while non-PM roles were presented with the latest PM-promoted APPROVED drawing as their operational reference.

Section 3: Evidence Mapping to Research Claims

Table E3 links each major research claim to the corresponding system evidence. Appendix E is the ledger-of-record for system totals, while Appendices B and F provide illustrative operational extracts. Appendix E is the record for system totals. Appendices B and F provide illustrative operational extracts.

Table E3

Evidence Mapping to Research Claims

Research claim	System evidence	Evidence location
Secure digital workflow implemented in one active project	The main controlled drawing, pricing, and fabrication sections within project folder PN-[Anonymized] contain 73 files stored in structured subdirectories across the 13-month operational period from February 2025 to February 2026. The project timeline contains 23 role-coded records with 107 attachments. The system database confirms project initiation, classification progress, and stakeholder registration from the beginning of the project.	File structure, Section 1. Appendix B, Extract 1.
Version histories and approval logs recorded across the project lifecycle	The drawing folder contains 3 APPROVED batches (March 2025, March 2025, August 2025) and 1 HOLD batch. Each batch retains its files permanently; nothing is overwritten. The controlled drawing-batch sequence is traceable from the first PM-promoted APPROVED drawing batch (2025-03-04) through the final PM-promoted APPROVED batch (2025-08-25). No CANCELED drawing batches were recorded during the intervention project. Drawing progress was managed through APPROVED and HOLD classifications. CANCELED status remained available for batches explicitly withdrawn or discontinued by a documented project decision. Promotion of a later APPROVED drawing batch did not automatically reclassify an earlier APPROVED batch as CANCELED. In the intervention project, CANCELED status was used in the pricing section when Change Orders 3 and 4 were declined by the client.	File structure, latest_drawing/. Appendix B, Extract 4.
Role-based access structures applied across all four system roles	The implemented workflow platform contained 15 access control rules. Each role (PM, ENG, SITE, SHIP) had defined permissions. The system kept a clear distinction between ENG submission of drawing packages to the PUBLIC timeline and PM promotion of authoritative batches to the controlled drawing repository. All four roles were active across the project lifecycle, with activity timestamps spanning February 2025 to February 2026.	Access control table, Section 2. Appendix A, Section 2.
Detailed pricing records restricted to PM, with SITE limited to the latest summary	The pricing folder was stored only under latest pricing/PM/. Upload and full history access were limited to PM. SITE had read-only access to the latest confirmed pricing summary only. The record includes 5 INVOICES batches, 1 ESTIMATES batch, 1 HOLD batch (CO#3 pending), and 1 CANCELED batch (CO#3 and CO#4 declined by the client) across the project lifecycle.	File structure, latest pricing/. Access control table rows 7-9.
Fabrication tracking managed by SHIP with PM oversight	SHIP uploaded three fabrication tracking batches (November 2025, January 2026, February 2026), each covering a distinct delivery phase. PM retained technical system capability for oversight. All three observed fabrication uploads were performed by SHIP.	File structure, latest_fabrication/. Access control table row 10.
Scope changes handled through structured governance	Change Order 2 was accepted by the client and required revised engineering drawings. ENG submitted a new package on 2025-08-23, and PM promoted a new APPROVED batch on 2025-08-25, showing the revision cycle in operation. CO#1 was a cost or commercial item and did not require an engineering or drawing revision. Change Orders 3 and 4 were declined by the client. Their pricing batches were handled through HOLD (2026-02-03) and CANCELED (2026-02-10) statuses without opening a new engineering cycle.	File structure, latest drawing/APPROVED; latest_pricing/HOLD and CANCELED batches. Appendix A, Section 3.
PM-authorized manufacturing release used the current authoritative APPROVED shop drawings; SHIP executed the external transmission and managed subsequent fabrication tracking.	The system records the current authoritative APPROVED drawing batch and shows that SHIP uploaded three fabrication tracking batches. The workflow platform does not transmit files directly to the manufacturer or create a system-generated email transmission record. Under the documented operational process, SHIP transmitted the PM-authorized shop drawings through the organization's external email process. Original architectural drawings were not included, and the manufacturer had no direct system access.	File structure, latest_drawing/APPROVED and latest_fabrication/. Access control table. Appendix F, Stage 8.
Post-intervention: no version ambiguity or document-related errors observed	All 3 APPROVED drawing batches were retained in separate timestamped folders across the 13-month project lifecycle. The HOLD batch was archived and clearly distinguished from APPROVED versions. The controlled drawing-batch sequence is traceable from the first PM-promoted APPROVED drawing batch (2025-03-04) through the final PM-promoted APPROVED batch (2025-08-25). No CANCELED drawing batches were recorded, and no document-related errors from uncontrolled version circulation were observed during the intervention project.	File structure, APPROVED / HOLD. Appendix C.1, Indicators 1 and 2.

This appendix presents evidence extracted from the implemented workflow system. The file storage structure was generated automatically during live project operations from February 2025 to February 2026. The access control rules were taken from the implemented workflow platform. Project-identifying information has been removed. The evidence confirms that the intervention was implemented in a real operational project, governed structurally, and sustained across a full professional project lifecycle.

Appendix F: Multi-Role System Activity Records

Secure Digital Workflow: Representative Multi-Role Activity Across the Full Project Lifecycle

Project identity anonymized. User identities are anonymized under professional confidentiality requirements.

This appendix presents representative workflow activity across the four user roles (PM, ENG, SITE, and SHIP) and all eight stages of the secure digital workflow intervention. The stage records are representative operational extracts aligned with each workflow stage. They are not a complete transaction-level ledger; the full ledger remains in the live system. The extracts show that users with different roles and access levels used the workflow across the project lifecycle, from February 2025 to February 2026. The records are consistent with the role-based access controls, version discipline, and audit traceability documented in Appendix A and Appendix E.

Where Stage 8 includes communication outside the workflow platform, this appendix distinguishes the system-controlled drawing authority and PM authorization from the external email transmission performed by Shipping Control. The manufacturer was not a system user and had no direct access to the internal workflow platform.

Section 1: System Users and Role Summary

Table F1 summarizes the four operational system-user roles and their documented involvement in the intervention project.

Table F1

System Users and Role Summary

Role	System user	Workflow areas accessible	Activity in records	Confidentiality note
PM	Project Manager (Role ID: 1)	Full access to all workflow stages, all visibility scopes, authoritative batch promotion, and upload and management functions.	Project creation, timeline records, drawing batch promotion, pricing record management, manufacturing release oversight, and approval confirmations.	Full activity records remain in the live system. Identities are anonymized under professional confidentiality requirements.
ENG	Engineering Team (Role ID: 2)	Drawing preparation and submission to the PUBLIC timeline. Engineering outputs, revision records, and public timeline records only.	Shop drawing submissions with contextual notes. DWG and PDF files were submitted across four engineering records during the project lifecycle.	Full activity records remain in the live system. Identities are anonymized under professional confidentiality requirements.
SITE	Site Team (Role ID: 3)	Latest PM-promoted APPROVED drawing batch for site reference, site timeline records, read-only view of the latest pricing summary, and PUBLIC	Site observations, delivery inspections, and field verification records across five records during the project lifecycle.	Full activity records remain in the live system. Identities are anonymized under professional confidentiality requirements.

		scope records. SITE did not have access to the complete controlled drawing-repository history.		
SHIP	Shipping Control (Role ID: 4)	Latest PM-authorized APPROVED drawing batch for manufacturing use, latest fabrication and shipping tracking files, upload of fabrication-tracking batches, and PUBLIC timeline records. SHIP did not have access to the complete controlled drawing-repository history.	Fabrication tracking uploads across three delivery phases, plus a delivery notification record.	Full activity records remain in the live system. Identities are anonymized under professional confidentiality requirements.

Section 2: Activity Records by Workflow Stage and Role

Tables F2–F9 present the role-coded activity records for the eight workflow stages, from project initiation through manufacturing release and shipping control.

Table F2

Stage 1: Project Initiation Activity Records

Stage 1: Project initiation | Department: PM					
Role	**Action performed**	**Record type**	**Visibility**	**Files / attachments**	**Governance significance**
PM	Created the project workspace and registered the project stakeholders. Recorded the project number, classification (NEW), builder, architect, and project address.	System event: PROJECT_CREATED	PUBLIC	Project initiation record (auto-generated). Received architectural drawings, 2 PDF files. Project coordination communication reference, 1 PDF file.	Established the centralized project record from the beginning. All later workflow activity was linked to this initiation event. Operational project information, including the project address, builder and architect details, their professional contact information, and relevant project attachments, was available to the four authorized internal roles through the PUBLIC workflow. The project owner's name and personal contact information were not included in PUBLIC records or attachments. Confidential administration fields and contractual records remained under PM control.
PM	Added project notes covering material types and scope requirements. Updated notes as the scope developed.	User record: Project notes update	PUBLIC	No files attached. Notes recorded in the project workspace.	Kept project information in one centralized location instead of spreading it across email threads or individual documents.

Table F3

Stage 2: Design Inputs and Drawings Activity Records

Stage 2: Design inputs and drawings | Department: PM / ENG					
Role	**Action performed**	**Record type**	**Visibility**	**Files / attachments**	**Governance significance**
PM	Received and uploaded original architectural drawings from the architect. Recorded the receipt date and project reference in the timeline.	User record: Design input receipt	PUBLIC	Architectural drawings, PDF (2 files). Project coordination communication reference, PDF.	Stored original architectural drawings within the authorized internal workflow. Because the record used PUBLIC visibility, the record and its attachments were visible to the

					four authorized internal roles. PM and ENG had primary responsibility for technical use of the design inputs. Within the documented intervention evidence, no organizational release of the original architectural drawings to the manufacturer was identified. They served as the internal design reference for shop-drawing preparation.
ENG	Prepared and submitted the initial shop drawing package after reviewing the received architectural drawings. Recorded a technical note for a dimensional item and noted that cladding and supplementary item files were submitted for reference and would move forward in later stages.	User record: Engineering drawing submission	PUBLIC	10 files: shop drawing DWG source file, 3D render PDF, cladding highlight PDF, cladding shop drawing PDF, driveway highlight PDF, driveway shop drawing PDF, other items highlight PDF, other items shop drawing PDF, flatwork PDF, and interior PDF.	The engineering submission shows structured workflow use. Contextual notes recorded professional decisions and created a traceable record of reasoning that was not consistently available under the earlier email approach. Quantity and dimension data were embedded in the drawing files.

Table F4

Stage 3: Engineering Outputs and Version Control Activity Records

Stage 3: Engineering outputs and version control | Department: ENG / PM					
Role	**Action performed**	**Record type**	**Visibility**	**Files / attachments**	**Governance significance**
PM	Promoted the first approved drawing batch to the controlled drawing repository after PM review. The 6-file package (5 PDF + 1 DWG) established the initial APPROVED version as the active operational reference.	File batch: Drawing APPROVED	PUBLIC	Drawing package (5 PDF + 1 DWG). Status: APPROVED.	Created the first authoritative active version for all roles to reference.
PM	Placed supplementary drawing elements on HOLD pending client review and consultant feedback. The batch contained 4 PDF files.	File batch: Drawing HOLD	PUBLIC	Drawing elements (4 PDF). Status: HOLD.	HOLD status kept the batch out of active operational use while preserving it in the system pending review.
PM	Promoted the revised full drawing package after consultant review. The 10-file package (9 PDF + 1 DWG) became the new active approved version.	File batch: Drawing APPROVED (revised)	PUBLIC	Updated drawing package (9 PDF + 1 DWG). Status: APPROVED. Earlier APPROVED batch retained.	Maintained a structured version sequence. The earlier batch remained available as a historical record.
ENG	Submitted updated engineering drawings after approval of Change Order 2. A new ENG submission was prepared and recorded.	User record: Engineering drawing submission (CO#2)	PUBLIC	14 files: shop drawing DWG and 13 PDF outputs covering revised and new scope elements.	Shows the revision cycle operating during the active project lifecycle. The ENG submission led to a new authoritative APPROVED batch, confirming that the workflow could handle accepted scope changes.
PM	Promoted the final approved drawing package incorporating Change Order 2. The 14-file package (13 PDF + 1 DWG) was confirmed as the authoritative version for later fabrication phases.	File batch: Drawing APPROVED (final, including CO#2)	PUBLIC	Comprehensive drawing package (13 PDF + 1 DWG). Status: APPROVED.	Made the full version sequence traceable across all four batches. All prior batches remained in the system as historical records.

Table F5

Stage 4: Pricing and Costing Activity Records

Stage 4: Pricing and costing | Department: PM					
Role	**Action performed**	**Record type**	**Visibility**	**Files / attachments**	**Governance significance**
PM	Uploaded preliminary cost estimates to the PM-controlled pricing section.	File batch: Pricing ESTIMATES (PM-restricted section)	PM role: Restricted access	Representative files shown: cost estimate (PDF) and estimate worksheet (XLSX). Full ESTIMATES batch: 4 files (2 PDF + 2 XLSX), recorded in Appendix E, Section 1, latest_pricing/ESTIMATES. Status: ESTIMATES.	Recorded preliminary pricing in the PM-controlled pricing section. System permissions limited detailed pricing access to the Project Manager.
PM	Uploaded confirmed project proposals after client engagement. Multiple invoice batches were recorded as the scope was defined and agreed.	File batch: Pricing INVOICES (PM-restricted section)	PM role: Restricted access (SITE: latest summary only)	Invoice documents, PDF. Multiple batches covering the main contract and approved change orders. Status: INVOICES.	Managed confirmed pricing documentation in the PM-controlled pricing section. Detailed pricing history remained restricted to PM, while SITE had read-only access to the latest confirmed pricing summary only.
PM	placed the Change Order 3 pricing batch on HOLD pending the client decision on a proposed quantity increase in one area.	File batch: Pricing HOLD, CO#3 (PM-restricted section)	PM role: Restricted access	Change order document, PDF. Status: HOLD.	Recorded that the pricing decision was still pending. The HOLD status avoided premature confirmation of a proposed change before client approval. Because CO#3 did not proceed to implementation, no engineering revision cycle was initiated.
PM	Recorded a CANCELED batch after the client declined Change Orders 3 and 4.	File batch: Pricing CANCELED, CO#3 and CO#4 (PM-restricted section)	PM role: Restricted access	Declined change order documents, PDF. Status: CANCELED.	Formally recorded the client decision to decline these scope items. The records remained available for audit and contractual reference. No new engineering cycle was opened for the declined items, which matched the workflow governance rules.

Table F6

Stage 5: Client Review and Revisions Activity Records

Stage 5: Client review and revisions | Department: PM					
Role	**Action performed**	**Record type**	**Visibility**	**Files / attachments**	**Governance significance**
PM	Recorded notes from client meetings, including client feedback, revision instructions, and scope decisions, in the project timeline.	User record: Notes from meeting	PUBLIC	Meeting notes, JPG site photographs. Dates recorded in the timeline.	Recorded client feedback in the workflow and linked revision justification to specific timeline events.

PM	PM reviewed the updated drawing package submitted by ENG after approved client revisions and scope changes, then promoted the appropriate batch to APPROVED status.	Cross-stage reference: PM-promoted APPROVED drawing batch following accepted client revisions	PUBLIC	Revised drawing packages, PDF. Status: APPROVED.	Completed the revision cycle through ENG submission and PM-controlled authoritative promotion. Earlier APPROVED batches remained as historical approval records, and client revisions could be traced to the relevant meeting records. The corresponding drawing-batch promotion records are listed under Stage 3.

Table F7

Stage 6: Site Verification Activity Records

Stage 6: Site verification | Department: SITE					
Role	**Action performed**	**Record type**	**Visibility**	**Files / attachments**	**Governance significance**
SITE	Accessed the latest approved drawing for site reference and checked dimensions against site conditions across several visits.	System access: Drawing review	PUBLIC	Access to APPROVED drawing batch. Earlier batches and HOLD batches were not used as active references.	Limited SITE interaction to the latest approved version. SITE did not have access to pricing history, contractual records, the complete PM-controlled drawing-repository history, or the complete fabrication and shipping history. The project owner's name and personal contact information were not included in PUBLIC records or attachments.
SITE	Recorded site observations after field measurement and inspection activities across several visits.	User record: Site observation	PUBLIC	Site observation records and photographs (JPG and PNG). Field notes recorded in the timeline.	Documented site verification in the workflow and linked inspection activity to the approved drawing version used at the time.
SITE	Accessed the latest pricing summary for site budget coordination. Access was read-only and limited to the latest confirmed pricing entry.	System access: Latest pricing summary (read-only)	PM-restricted section: SITE read-only (latest only)	Read-only access to latest INVOICES entry. SITE cannot upload, modify, or access pricing history.	Allowed SITE limited access to the latest confirmed pricing summary for operational budget coordination only. Detailed pricing records and history remained restricted to PM through role-based system permissions.

Table F8

Stage 7: Approval and Contractual Confirmation Activity Records

Stage 7: Approval and contractual confirmation | Department: PM					
Role	**Action performed**	**Record type**	**Visibility**	**Files / attachments**	**Governance significance**
PM	Confirmed the PM-promoted APPROVED drawing batch as the current authoritative final drawing for project use. When a revision was required, ENG prepared and submitted an updated drawing package, and PM promoted the revised APPROVED batch as the new current authoritative final drawing.	Drawing APPROVED, current authoritative final version	PUBLIC	Approved shop drawing package contained in the applicable PM-promoted APPROVED batch.	Maintained one current authoritative final drawing at a time. When a revised APPROVED batch was promoted, the earlier APPROVED batch remained in the system as a historical approval record and ceased to be the current operational reference. Client and company approval communications were managed by PM outside the workflow system and are not presented as system files in this appendix.
PM	Recorded the final payment request and closing invoices in the PM-controlled pricing section.	File batch: Pricing INVOICES, final settlement (PM-restricted section)	PM role: Restricted access	Payment request documents, PDF. Status: INVOICES.	Maintained final financial records in the PM-controlled pricing section. This supported accountability and traceability at project closure.

Table F9

Stage 8: Manufacturing Release and Shipping Control Activity Records

Stage 8: Manufacturing release and shipping control | Department: PM / SHIP					
Role	**Action performed**	**Record type**	**Visibility**	**Files / attachments**	**Governance significance**
PM	Authorized the current authoritative APPROVED shop-drawing batch for manufacturing use. PM retained authority over drawing approval and manufacturing release but did not transmit files through the workflow system.	Operational governance action linked to the current authoritative APPROVED drawing batch	Internal workflow reference	Current authoritative APPROVED shop drawings, PDF. Original architectural drawings were not authorized for manufacturing transmission.	PM retained authority to determine which approved drawing package could be used for manufacturing. SHIP could not select a different drawing package or independently authorize external release.
SHIP	Following PM authorization, transmitted the authorized shop drawings to the manufacturer through the organization's external email process.	Operational activity summary: external email communication outside the workflow platform	External email, outside the internal workflow system	PM-authorized shop drawings from the current authoritative APPROVED drawing batch. Original architectural drawings were not included.	SHIP executed the external transmission but did not determine drawing authority or independently authorize manufacturing release. The manufacturer had no direct access to the internal workflow system.
SHIP	Uploaded the fabrication tracking worksheet after the first delivery phase arrived at the project site.	File batch: Fabrication tracking, Phase 1	Fabrication section (SHIP uploads; PM oversight;	Fabrication control worksheet, XLSX. Phase 1 arrival status recorded.	SHIP uploaded delivery tracking to the fabrication section. Access followed role permissions: SHIP and PM could manage the full tracking history, while SITE could view the latest entry for site coordination.

Stage 8: Manufacturing release and shipping control | Department: PM / SHIP					
Role	**Action performed**	**Record type**	**Visibility**	**Files / attachments**	**Governance significance**
			SITE: latest view)		
SHIP	Uploaded the fabrication tracking worksheet after the second delivery phase arrived.	File batch: Fabrication tracking, Phase 2	Fabrication section (SHIP uploads; PM oversight; SITE: latest view)	Fabrication control worksheet, XLSX. Phase 2 arrival status recorded.	Continued structured delivery tracking across delivery phases. The fabrication section retained a traceable sequence from the first delivery batch to the final delivery batch.
SHIP	Uploaded the fabrication tracking worksheet after the final balance of items arrived.	File batch: Fabrication tracking, Phase 3 (balance)	Fabrication section (SHIP uploads; PM oversight; SITE: latest view)	Fabrication control worksheet, XLSX. Balance of items arrival status recorded.	Documented the final delivery phase. The full fabrication tracking sequence remained traceable from initial delivery through final balance, supporting project closure.
SHIP	Recorded a delivery notification in the public project timeline after the final item arrived.	User record: Delivery notification	PUBLIC	Notification record. No file attachment.	Recorded delivery status in the public timeline so all project roles could see it. This supported SITE and PM coordination for final inspection and project closure.
SITE	Recorded delivery receipt and inspection confirmation in the project timeline.	User record: Site confirmation	PUBLIC	Confirmation record. No file attachment.	Recorded final inspection confirmation in the workflow timeline, supporting project closure documentation.

The activity records in this appendix reflect the workflow structure and system capabilities used during the intervention project. The records show role-based access control, version discipline, and audit traceability operating across the workflow stages and user roles listed above. Complete records, including user identifiers, detailed activity chronology, and file names, remain in the live system under organizational confidentiality controls.

Appendix G: Organizational Confirmation of Awareness and Authorization

This appendix contains written confirmation from senior organizational leadership. The letter records the owner/director's awareness of the operational problems that led to the study, their approval of the workflow initiative before the project began, their awareness during implementation, and their observation of the results after project closure. The letter was signed after the project closed so it could cover the whole intervention period. Identifying details have been removed to protect confidentiality.

Organizational confirmation letter

To Whom It May Concern,

I am writing as Owner and Director of the organization in which this research was conducted.

I confirm the following:

I was aware of recurring operational challenges in the organization before this research began. These included problems with document version control, approval traceability, data protection, and fragmented workflows in natural stone project delivery. Through direct organizational oversight, I was also aware of the operational consequences, including fabrication errors, coordination inefficiencies, and uncontrolled information sharing. I recognized these issues as requiring a structured improvement response.

The researcher presented the proposed workflow improvement initiative to me before implementation. I approved the initiative before the intervention project began and supported it as a legitimate and necessary organizational development effort.

I remained aware of the initiative's progress during implementation and observed its day-to-day effect on project coordination and information management within the organization.

I confirm that the improvements observed after implementation reflect genuine and observable changes in professional practice within the organization. I observed these changes through ongoing organizational oversight across the project lifecycle.

This confirmation is provided after the intervention project concluded. It confirms the full scope of operational conditions and outcomes observed, from the pre-existing challenges before commencement to the changes in professional practice observed at project closure. This letter also confirms that approval for the initiative was granted before the project start.

I confirm that participation in the research remained within appropriate professional and organizational boundaries.

Signed: .....

Position: Owner / Director

Organization: [Anonymized in accordance with research confidentiality requirements]

Date: [Post-completion confirmation, following project closure in February 2026. Signed original, including exact date, retained on file]

Note. This letter is a post-completion confirmation. It records the owner/director's prior approval of the initiative, granted before project commencement on 2025-02-02, their awareness during implementation, and their observation of the intervention outcomes. The timing after project completion allowed the owner/director to confirm the full operational arc, from the baseline challenges to the outcomes observed at project closure. The researcher retains the signed original, including full organizational and signatory details and the exact signature date, in line with the research program's data management requirements. Identifying details have been removed from this copy only to preserve the study's confidentiality commitments. This confirmation records organizational awareness and authorization for the workflow initiative and the use of anonymized, process-level evidence. It is not presented as individual informed consent, institutional ethics approval, or independent validation of the research findings.

The Owner/Director’s evaluative statements represent organizational observations and were not used to assign the retrospective baseline ratings, post-intervention indicator ratings, or other analytical findings reported in the study.

Appendix H: Internal Workflow Handbook

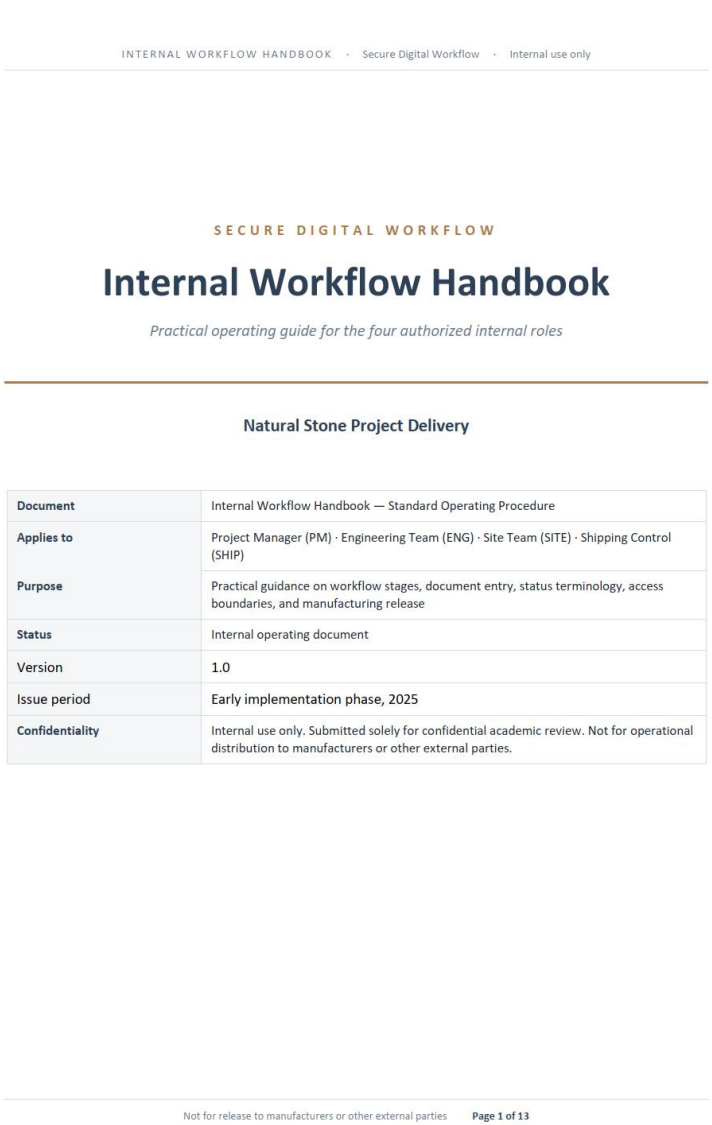
Documentary record of implementation guidance

This appendix presents the cover page of the Internal Workflow Handbook used to support the early implementation of the secure digital workflow. The handbook provided practical guidance on workflow stages, role responsibilities, record-entry requirements, version and batch control, status terminology, access boundaries, and manufacturing-release procedures. Figure H1 presents the cover page of the handbook.

The handbook is included as contextual evidence of implementation support. The reported intervention outcomes are evaluated through the structured comparison, indicator tracking, system evidence, and multi-role activity records presented in Appendices C.1, C.2, E, and F. The complete handbook is retained by the researcher and is available to the doctoral program or examiners upon request.

Figure H1

Cover page of the Internal Workflow Handbook, Version 1.0, Early implementation phase, 2025



INTERNAL WORKFLOW HANDBOOK · Secure Digital Workflow · Internal use only

SECURE DIGITAL WORKFLOW

Internal Workflow Handbook

Practical operating guide for the four authorized internal roles

Natural Stone Project Delivery

Document	Internal Workflow Handbook — Standard Operating Procedure
Applies to	Project Manager (PM) · Engineering Team (ENG) · Site Team (SITE) · Shipping Control (SHIP)
Purpose	Practical guidance on workflow stages, document entry, status terminology, access boundaries, and manufacturing release
Status	Internal operating document
Version	1.0
Issue period	Early implementation phase, 2025
Confidentiality	Internal use only. Submitted solely for confidential academic review. Not for operational distribution to manufacturers or other external parties.

Not for release to manufacturers or other external parties **Page 1 of 13**