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PERCEIVED BARRIERS TO DIGITAL TECHNOLOGY ADOPTION IN UK CONSTRUCTION: EVIDENCE FROM CLERK OF WORKS, CONSTRUCTION INSPECTORATE AND QUALITY CONTROL MANAGEMENT

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Abstract

This study investigates the perceived barriers to digital technology adoption in the UK construction industry, focusing on Clerk of Works and Construction Inspectorate (CWCI) and Quality Control Management (QCM) roles, primarily within residential projects. A mixed-methods approach was used, combining document analysis, a structured survey (n = 20), and semi-structured interviews (n = 4). Data were analysed using inductive thematic coding and Relative Importance Index (RII). Five key barriers were identified: cost, lack of training and support, human behaviour, data security, and fragmentation. Empirical findings indicate that digital tools are widely used and improve efficiency, accuracy, traceability, and collaboration. However, adoption remains constrained by organisational and behavioural factors. Cost was identified as the most significant barrier, followed by resistance to change and lack of training and support, while fragmentation and data security were less significant. A disconnect between ISO 9001 principles and their digital implementation was identified, alongside operational constraints such as usability, administrative burden, and site conditions. The study concludes that organisational and behavioural factors present greater challenges than technological limitations. Targeted strategies, including improved training, leadership commitment, system standardisation, and strengthened digital governance, are suggested to support effective adoption.

Keywords: digital technology adoption; clerk of works and constructor inspectorate; BIM; quality control management; perceived barriers to digital technology adoption.

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1. Introduction

According to the academic community, the role of the Clerk of Works and Construction Inspectorate (CWCI) has evolved significantly over the past two decades in response to increased demand for accountability, traceability, and quality assurance within the UK construction industry. Contractually, CWCI professionals monitor quality, materials, and workmanship to ensure compliance with contractual and regulatory requirements. Traditionally, this relied on paper-based reporting, including handwritten site diaries and photographic records, which were time-consuming and often inconsistent [1].

Advances in digital technology have introduced opportunities to enhance reporting, communication, and record-keeping. Digital technologies such as mobile inspection tools, cloud-based platforms, and Building Information Modeling (BIM) now enable real-time data capture, more efficient reporting, enhanced collaboration, and stronger audit trails. These systems support improved coordination and more consistent quality management [2]. However, adoption remains inconsistent due to

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organisational, behavioural, and structural barriers, including fragmentation and lack of standardisation [3, 4].

This study provides an empirical exploration of perceived barriers to digital technology adoption within CWCI and quality control management (QCM) roles in the UK construction industry, primarily within residential projects. It offers practice-based insights into inspection-focused quality management processes, which remain underexplored in digital construction research. By identifying these barriers and reflecting on potential solutions, the research aims to support improved understanding of perceived barriers and more effective implementation of digital quality management practices.

2. Literature Review

This section examines the development of inspection practices, the role of digital technologies in construction quality management, and the key perceived barriers to their adoption in the UK construction industry, with a focus on CWCI and QCM roles. The study draws primarily on existing peer-reviewed literature, supported by industry sources to reflect both academic and practice-based perspectives. Existing literature demonstrates the growing use of digital tools across construction; however, inspection-specific roles remain underexplored, particularly in relation to site-based quality control processes. This gap provides a basis for this study.

2.1. Evolution of the CWCI and reporting practices

Contractually or through appointment, the CWCI represents the interests of the client or contract administrator. The CWCI role involves site inspections and monitoring to ensure compliance with contractual and quality requirements. This includes witnessing tests on-site, identifying defects, producing regular reports, and completing a site diary [1]. Traditionally, this relied on paper-based reporting systems, including handwritten site diaries and manual records, which were time-consuming and susceptible to inconsistency.

The transition to digital reporting has improved efficiency, communication, and record accuracy. Digital records are now widely accepted for contractual and legal purposes. Mobile and cloud-based technologies enable real-time data capture, improved accessibility, traceability, and auditability across project stakeholders. CWCI responsibilities have evolved to incorporate digital reporting processes [2].

This transformation reflects a broader move towards more structured and consistent quality management practices, with digital tools supporting improved documentation and auditability. However, the effectiveness of this transition depends on organisational adoption and system integration.

2.2. Digital technologies in construction quality management

Digital technologies, including mobile reporting applications, Building Information Modelling (BIM), cloud-based systems, reality capture tools, and data analytics, play a key role in construction quality management. They enable structured data capture, improved communication, and enhanced coordination between stakeholders [2]. Mobile tools are particularly significant in supporting real-time recording of inspections and defects, improving efficiency and data accuracy in site-based quality processes [5, 6].

Despite these advantages, challenges remain in system integration and interoperability. Fragmented digital environments and duplicated data [7, 8]. As a result, adoption relies on effective integration, standardisation, and organisational processes, reflecting the increasingly digital nature of CWCIs roles.

2.3. Use of digital technologies in ISO 9001 quality management

International Organisation for Standardisation (ISO) 9001 provides a structured framework for quality management systems, based on principles including standardisation, traceability, risk-based thinking, and continual improvement [9]. In construction, these principles support consistent monitoring of quality, documentation control, and evidence-based decision-making.

Table 1 demonstrates how digital technologies operationalise these principles through structured data capture, real-time reporting, and improved traceability, enhancing coordination in quality processes [10]. Digital tools used do not replace professional judgment but support CWCI and quality roles through more consistent defect identification, compliance monitoring, and auditable records, supporting a shift from reactive inspections to more proactive, data-driven quality management.

However, their effectiveness depends on implementation quality, user adoption, and system integration, resulting in uneven impact across projects.

Table 1. Digital technologies used in quality-related roles aligned with ISO 9001 principles [Source: Author]

Technology	Use in quality-related roles and ISO 9001 aligned quality outcomes
Dashpivot / sitemate	Enables structured, real-time data capture, improves traceability and auditability (Clause 7.5, 9). Effectiveness depends on standardsing inspection workflows consistent use and data input quality [11].
Planradar	Supports centralised defect and RFI management, strengthening operational control and corrective actions (Clause 8, 10). However, its analytical value is contingent on cross-team adoption; partial use limits system-wide visibility and reduces its effectiveness as a coordination tool [12].
Site audit pro	Supports standardised inspections and audits, improving consistency and performance monitoring (Clause 8, 9). Limited interoperability reduces feedback capacity [13].
Viewpoint field view	Integrates defect management with workflow tracking, reinforcing accountability and process control (Clause 8, 9, 10). Impact depends on system integration [14].
Openspace & evercam	Provides visual records to support verification, audit trails, and dispute resolution (Clause 7.5, 9). Limited process integration [15, 16].
BIM	Supports early identification of design and coordination risks, supporting risk-based thinking and reducing rework (Clause 6, 10). Its impact is primarily at the design-stage and strategic level, with limited direct influence on site-level inspection unless linked to field data systems [17].

These technologies broadly align with ISO 9001 principles; however, their contribution to quality outcomes is not inherent but contingent on implementation maturity, interoperability, and organisational practices. This highlights that digitalisation alone does not guarantee improved quality performance.

2.4. Identified perceived barriers to digital technology adoption

A structured literature review was conducted to identify recurring barriers to digital technology adoption within the UK construction industry. An inductive thematic analysis of peer-reviewed studies identified five key themes based on frequency of occurrence and conceptual alignment: cost, lack of training and support, human behaviour, data security, and industry fragmentation. These themes are consistent with established research on non-technical barriers to digital technology adoption in construction [3, 4, 18].

a. Cost

Cost is consistently identified as a primary barrier to digital technology adoption, particularly in relations to software procurement, implementation and training [4, 19, 20]. High upfront and ongoing costs including hardware and service charges, limit adoption [7].

Achieving a return on investment can be challenging due to the need for specialist ICT expertise, which is often limited within organisations [21]. Recruiting and training skilled professionals further increases resource pressures [7, 19, 22]. Cost considerations are closely linked to maintaining effective quality processes within organisational constraints [23].

b. Lack of training and organisation support

Limited training, technical capability, and organisational support are key barriers to adoption of digital technology. Contributing factors include time constraints, insufficient resources, and an aging workforce [7, 19, 24, 25].

Technical challenges such as interoperability issues and poor usability, further complicate implementation [7]. In addition, the lack of suitable devices and their limited system capabilities. Inconsistent quality control systems and reporting practices across organisations create further barriers [20, 21, 23].

A lack of senior management support reduces effective communication and resource allocation, limiting user competence and consistency in system use [4, 7, 20, 21].

c. Human behaviour and error

Human behaviour and organisational culture are key determinants of digital technology adoption. Resistance to change is widely recognised as a significant barrier within the UK construction industry, often driven by perceived risk related to cost, uncertainty, and workflow disruption [7, 21, 25].

Variations in digital literacy and individual attitudes towards innovation influence engagement with new systems [1, 26, 27]. Entrenched cultural practices, particularly among experienced professionals, further limit adoption [1].

Effective digital transformation requires organisational cultures that support continuous improvement. However, this is constrained by skills gaps, leadership challenges, and behavioural factors [28–30]. In addition, barriers relating to competency, coordination, and communication contribute to inefficiencies, while ongoing skills shortages and workforce ageing increase implementation challenges [7, 22, 25, 30, 31].

d. Data security

While cloud-based systems are designed to protect sensitive information, concerns around data security, data loss, and system reliability continue to affect trust in digital systems [32].

e. Industry fragmentation

Fragmentation within the UK construction industry is widely recognised as a barrier to efficiency, coordination, and innovation, and continues to affect digital transformation [8, 33]. It complicates communication and standardisation across stakeholders, undermining collaboration and leading to poor information exchange, inadequate task coordination, and weak progress monitoring, which can negatively impact project quality [2]. Contributing factors include insufficient managerial commitment to digital processes [24].

3. Methodology

The research adopts a mixed-method research design. It combines document analysis, a structured survey, and semi-structured interviews to explore digital technology adoption in CWCI and QCM roles within the UK construction industry. This approach provides breadth and depth through triangulation.

Quantitative data were collected through a structured survey containing Likert-scale and multiple-choice questions, supported by several open-ended questions. Qualitative data were obtained through semi-structured interviews. These allowed for deeper exploration of participant experiences and perceptions. Document analysis formed the initial stage of the research. Peer-reviewed literature, industry reports, and professional publications were reviewed to identify recurring barriers to digital technology adoption. An inductive thematic analysis identified five key themes based on frequency of occurrence and conceptual alignment: cost, human behaviour, lack of training and support, data security concerns, and industry fragmentation. These themes informed the design of prompted survey questions, ensuring consistency of terminology and interpretation. Interview questions were developed following preliminary survey analysis, to explore emerging patterns and expand on key themes. Interviews were designed to be open-ended and unbiased, allowing participants to express perspectives freely. Follow-up prompts were used where appropriate to clarify responses and provide depth, strengthening coherence across research stages. A targeted cross-sectional design was adopted, with data collected at a single point in time. Survey data were analysed using descriptive statistics and the Relative Importance Index (RII) to identify trends, assess frequency distributions, and rank the relative significance of perceived barriers. Qualitative data were analysed using thematic analysis. Findings were triangulated to enhance credibility and validity [18, 34]. The sampling targeted UK construction professionals in quality-related roles, including CWCI and QCM practitioners, ensuring responses were grounded in relevant practical experience. The survey was distributed electronically via Google Forms to 40 construction professionals, with 20 responses (n = 20). While limited, this sample size is appropriate for exploratory research focused on a specialised group, where depth of insight is prioritised over statistical generalisability [18]. In addition, four semi-structured interviews (from five invitations) were conducted, further strengthening the dataset through triangulation. The sample provided sufficient depth for thematic analysis. The findings are therefore context specific. The study primarily reflects residential construction projects. This may influence the applicability of the identified perceived barriers. The findings should therefore be interpreted within this context. Ethical considerations for the surveys and interviews included voluntary participation, informed consent, and the right to withdraw. Data were anonymised, managed confidentially, and stored securely. Research positionality was acknowledged, as the authors include practicing CWCIs and a Construction Design & Quality Manager (CDQM). Potential bias was mitigated through structured data collection, consistent interview protocols, and reflective analysis.

Overall, the pragmatic, multi-method design ensures that findings are grounded in empirical evidence and strengthened through triangulation [18]. Additional themes also emerged during the research process, reflecting evolving industry conditions.

4. Results

This section presents the findings supported through triangulation of empirical data derived from document analysis, survey data (n = 20), and semi-structured interviews (n = 4). Pseudonyms are used to preserve anonymity. The findings are presented using text, tables, and figures, and are structured around the five key themes identified in the literature review: cost; lack of training and support;

human behaviour/error; data security; and fragmentation. This alignment strengthens the analytical framework and links empirical findings to existing literature.

a. Participant overview

The sample represents UK construction professionals in quality-related roles, including CWCIs, site managers, and senior leadership positions (Table 2). The dataset is strongly aligned with residential construction projects, including new-build housing, high-rise developments, and fire remediation projects.

Table 2. Summary of Survey and Interview Participants by Role [Author].

Data source	Participants	n
Survey	CWCIs (7), Site managers (2), Project manager (PM) (1), Construction director (1), CDQM (1), Head of development (1), Head of design & quality (1), Quality management lead (1), PM trainee (1), Coordinator (1), Senior asset manager (1), Head of project quality (1).	20
Interviews	Phil (Fire remediation CWCI), Greg (CWCI), Dan (Senior CWCI), and Alex (CDQM).	4

Survey respondents had varied industry experience. 55% reported 21+ years', 15% had 11-20 years, 5% had 6-10 years, and 25% had 0-5 years. All interviewees had 20+ years' experience, reflecting the experience-based nature of CWCI roles and supporting the reliability of the qualitative insights.

The sample also reflects the current male-dominated structure of the UK construction industry. More experienced respondents provided deeper, practice-based insights. The combination of survey and interview data strengthens interpretation through triangulation. It demonstrates how qualitative insight provides a more comprehensive understanding of the quantitative results.

b. Digital technology usage

Respondents reported on a range of digital tools used in quality-related activities, including mobile inspection platforms, document management systems, and digital reporting applications (Fig. 1). Interview responses provided additional context. Phil reported using Word-based reports supported with photographs stored on SharePoint. Greg described using Site Audit Pro for site inspections. Dan and Greg referenced structured inspection tools such as Dashpivot and Site Audit Pro for site inspection and defects tracking, with geo-tags, time and date stamped photographs. Alex described reviewing digital reports and using its analytical features within Dashpivot.

Survey data indicates a digitally engaged sample: Overall, 65% reported being very familiar or expert users, 25% moderately familiar, and 10% with limited familiarity. In terms of usage: 60% use digital tools daily, 20% weekly, and 20% infrequently. 95% of respondents reported improved efficiency, 45% indicating significant improvement, and 50% moderate improvement. All respondents rated digital tools as at least moderately effective in supporting quality-related activities, with 70% rating them as "very" or "extremely effective." (Fig. 2).

Reported benefits included improved efficiency, accuracy, traceability, record-keeping, and enhanced communication and collaboration. These findings are consistent with research indicating that digital technologies enhance coordination and data reliability in construction QCM [2].

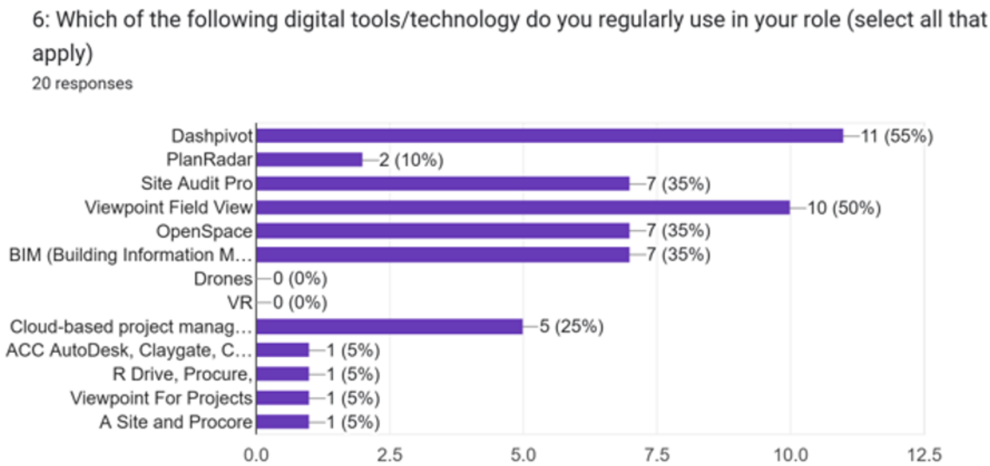

Figure 1. Digital tools/technology regularly used by survey respondents

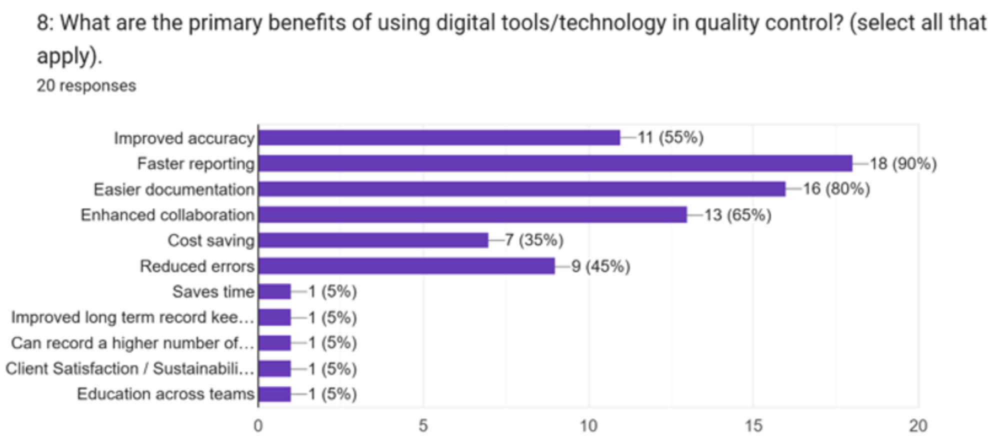

Figure 2. Primary benefits of using digital tools/technology in quality control by survey respondents

c. Quantitative ranking of barriers (RII Analysis)

The Relative Importance Index (RII) (Eq. (1)) was used to rank the perceived barrier to digital technology adoption. Respondents selected up to three barriers, and results were normalised against the sample size (n = 20).

$$\mathrm{RII} = \frac{\sum W}{AN} \tag{1}$$

where W is frequency; A is the highest weight; N is total respondents

Table 3. Ranked barriers using RII [source: author]

Perceived barrier	Frequency (%)	Frequency (n)	RII	Rank
Cost	65%	13	0.65	1
Human behaviour/resistance to change	55%	11	0.55	2
Lack of training and support	50%	10	0.50	3
Fragmentation	30%	6	0.30	4
Data security	5%	1	0.05	5

The analysis identifies cost as the most significant barrier (RII = 0.65), followed by human behaviour (RII = 0.55) and lack of training and support (RII = 0.50). Fragmentation (RII = 0.30) and data security (RII=0.05) were ranked lower. These findings align with existing research, where cost and behavioural factors are consistently identified as the primary constraints to digital adoption in construction [4].

d. Cost

Cost was identified by 65% of survey respondents as a perceived barrier (RII = 0.65), making it the most significant factor. However, 35% indicated cost saving as a perceived benefit, highlighting tension between short-term investment and long-term value. Interview data supports this finding. Phil described a bespoke reporting system that was not adopted due to high cost. Alex highlighted financial implications of subscription-based contractor platforms and long-term data storage. Greg and Dan noted that investment decisions are typically made at organisation level, limiting practitioner influence.

e. Human behaviour and resistance

Human behaviour and resistance to change was identified by 55% of survey respondents (RII = 0.55), making this the second most significant barrier. Interview data highlighted generational resistance, varying levels of digital competency, and differences in attitudes towards digital technology adoption. Phil identified challenges in adapting to new systems. Greg and Dan highlighted inconsistent skill levels across teams. Alex described challenges in achieving consistent adoption of revised reporting templates and processes across project teams. All interviewees emphasized that the CWCI role remains advisory in nature, relying heavily on professional judgement, verbal communication and formal reporting. This suggests that the adoption of digital technology is influenced not only by system capability but also by behavioural and cultural factors. This aligns with research identifying resistance to change as a key constraint on digital transformation in construction [3].

f. Lack of training and support

Lack of training and support was identified by 50% of survey respondents (RII = 0.50), making it a key barrier. While 80% reported being "somewhat" or "very confident" in using digital tools, gaps remain in structured training and consistent system use. Interview data indicated reliance on informal training, including shadowing and on-the-job experience. Alex highlighted the need for refresher training to improve consistency. 20% of survey respondents also identified limited management support. Several respondents also highlighted that existing quality management systems, including those aligned with ISO 9001 [9], are often not fully integrated into site-based digital workflows. This limits their practical application within CWCI and QCM roles and reduces consistency in reporting and compliance processes.

g. Fragmentation between systems

Fragmentation was identified by 30% of survey respondents (RII = 0.30). Participants reported using multiple non-integrated systems across projects. Interview data highlighted this issue. Phil referenced Procore, Fieldview, and Dalux being used independently across different projects. Alex described navigating multiple contractor portals for drawings and documentation. Dan referenced integration between Dashpivot and defect tracking systems. Greg identified file separation between inspection reports and quality tracking. This resulted in duplicated work, inconsistent data, and reduced efficiency. These findings reflect the fragmented nature of the UK construction industry, which limits integration and standardisation across stakeholders [8].

h. Data security

Data security was identified by 5% of survey respondents (RII = 0.05), making it the lowest ranked barrier. Interview data suggests its importance may be underestimated. Phil highlighted risks of data loss and reliance on devices. Alex raised concerns about contractor-controlled systems, particularly in cases of insolvency or loss of access. Dan noted the importance of accurate reporting for legal defensibility. Greg expressed confidence in current systems, supported by standards and collaborative review. The findings suggest that data security is not a primary barrier to adoption but remains important for long-term reliability, auditability, and trust in digital systems [32].

i. Additional emerging barriers

Additional barriers emerged beyond the primary five key themes. These included usability issues, administrative burden, and site constraints.

Participants highlighted usability challenges, particularly the time required to complete detailed digital inspection reports. Phil noted that report preparation can take several hours post site inspection. Alex described some reporting templates as lengthy and complex. Operational constraints were also identified. Greg referenced connectivity limitations on-site, while Dan highlighted device-related issues such as battery life and durability. Environmental conditions, including weather, are also noted as affecting usability. Dependence on external controlled platforms was raised as a concern. Alex noted that project data is often stored within contractor-managed systems, potentially affecting long-term accessibility.

j. Future outlook

Participants anticipated continued development in digital technologies within CWCI and QCM roles. These include improved integration, enhanced reporting accuracy, and AI-assisted tools. Phil referenced developments in geo-tagging photographs, QR codes, and more precise reporting. Greg emphasised the continued importance of human oversight alongside digital systems. Dan referenced ongoing regulatory requirements for documentation standards. Alex noted the potential for greater system integration, AI-assisted reporting, and BIM-linked quality tracking. Despite these advancements, all interviewees agreed that professional judgement and experience remain central to the role. Digital systems are viewed as supportive tools rather than replacements for inspection expertise.

k. Summary of Findings

The findings identified four primary categories of barriers: economic (cost), behavioural (resistance to change), capability (training and support), and technical (fragmentation). RII analysis demonstrates that cost and behavioural factors are more influential than technical barriers within this sample. The triangulation of survey and interview data highlights that some issues, such as data security, may be underrepresented quantitatively but remain important in practice. Despite the identified perceived barriers, digital tools are widely perceived to improve efficiency, accuracy, traceability, and record-keeping. Participants confirmed that digital records are suitable for legal proceedings, reinforcing their significance within quality control processes. The findings further indicate a disconnect between ISO 9001 principles and their digital implementation within CWCI and QCM roles. Organisational and operational factors limit consistent use in practice. These relationships are summarised in Fig. 3, which illustrates how organisational, behavioural, and technological factors influence the effectiveness of digital technology adoption.

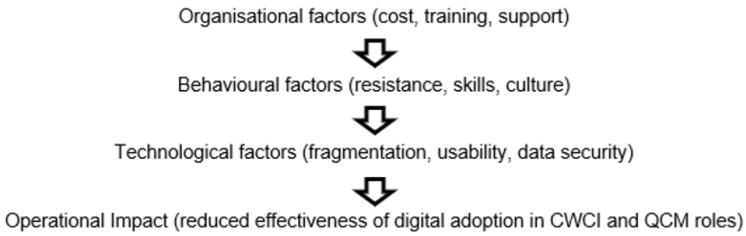

Figure 3. Conceptual framework of barriers to digital technology adoption in CWCI and QCM [Author]

5. Conclusions

This study investigated the perceived barriers and benefits associated with digital technology adoption in UK construction inspection and quality control management, focusing on CWCI and QCM roles within residential projects. It draws on survey data (n = 20) and semi-structured interviews (n = 4). While the sample size is limited and not statistically representative of the wider industry, it is appropriate for exploratory research and provides relevant insight into practitioner experiences in quality-related roles.

The findings highlight the influence of organisational and behavioural factors on digital technology adoption. Cost emerged as the most significant barrier (RII = 0.65), followed by human behaviour and resistance to change (RII = 0.55) and lack of training and support (RII = 0.50). These findings align with existing research on digital technology adoption barriers in construction, reinforcing the view that organisational and behavioural factors remain the primary constraints to digital transformation [4]. Despite these constraints, digital tools are widely used and improve operational efficiency, traceability, and coordination. However, the results confirm that barriers are primarily organisational and behavioural rather than technological, supporting the argument that digital transformation is constrained more by organisational capacity than technological availability [3]. Cost remains a key challenge due to investment requirements and uncertain returns. This indicates a disconnect between operational benefits and organisational decision-making. A shift towards long-term, value-based investment approaches is therefore recommended [18]. Human behaviour, resistance to change and variations in digital competence further limit digital technology adoption. Addressing this requires structured change management, including role-specific training, peer-led learning, and "digital champions" within teams [4]. Training and organisational support remain inconsistent. Current approaches rely on informal learning and lack standardisation. Organisations should implement structured training frameworks aligned with role-specific tasks, supported by clear guidance within digital systems. Fragmentation across systems reduces efficiency and leads to inconsistent data. While integration is important, the findings highlight the need to balance integration with independence in inspection roles. Standardised and interoperable systems are therefore required [8]. A disconnect between ISO 9001 principles and their digital implementation was identified. Organisational and operational barriers limit consistent application in practice [4, 10]. Although data security ranked low (RII=0.05), qualitative findings highlight concerns around data ownership, access, and long-term reliability. Organisations should adopt stronger digital governance, including clear data ownership, independent storage, and long-term access arrangements [32]. Additional challenges include usability, administrative burden, and site constraints. These indicate that digital tools are not always aligned with site conditions. Systems should therefore prioritise usability and minimise administrative effort. Digital technologies demonstrate clear benefits for construction quality management, including improved documentation and auditability. They are also increasingly accepted in legal contexts, reinforcing their importance in CWCI practice [1]. Future developments, including AI and data-driven tools, offer further potential to enhance quality management. However, adoption will continue to depend on organisational readiness and technical capability [35, 36]. Digital tools should support, rather than replace, professional judgement. This study has several limitations. The sample size is small and focused on quality-related roles within residential construction. This is appropriate for exploratory research as the sample does not reflect the full diversity of the UK construction industry in terms of project type, scale, and organisational structure. The findings are therefore context-specific and not statistically generalisable. Future research should use larger and more stratified samples across different project types and organisational sizes. Further work could also examine the link between digital technology adoption and measurable project outcomes, such as defect reduction and cost performance. While digital technologies offer clear benefits for construction quality management, their effectiveness depends on organisational capabilities, behavioural readiness, and structured implementation. Addressing these factors is essential to support effective adoption. Without these measures, the full potential of digital technologies in construction QCM remains unrealised.

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