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BIM AND ISO 19650 IMPLEMENTATION IN THE WELSH CONSTRUCTION INDUSTRY: A CASE STUDY OF BOTTOM-UP GOVERNANCE IN A NON-MANDATED REGION

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SUMMARY: *While many regions have accelerated Building Information Modelling (BIM) through government mandates, many jurisdictions must pursue adoption without centralised enforcement. This raises a key question: what governance arrangements enable consistent BIM information management and ISO 19650 alignment in non-mandated settings? This paper addresses this question through a longitudinal case study of Wales, a devolved UK region without a devolved BIM mandate, programmatic funding, or a coordinated implementation framework. Using a qualitative-dominant mixed-methods design comprising stakeholder workshops (2017-2023), semi-structured interviews, and a structured survey of contractors and local authorities, the study examines how stakeholders interpret and operationalise ISO 19650 in practice. The results indicate that reported BIM tool use is widespread, yet formal standards-aligned implementation is substantially lower, revealing a persistent gap between software adoption and ISO 19650-oriented information management. Across data sources, recurring governance constraints include weak and inconsistent client-side commissioning of information requirements, project documentation that is produced primarily for compliance rather than embedded coordination, and ambiguity in information management roles and accountabilities across the project lifecycle. Rather than treating mandates as a prerequisite, the study argues that governance maturity is a primary enabling condition for ISO 19650 alignment in non-mandated contexts. The paper contributes empirical evidence on bottom-up BIM governance and proposes practical, non-legislative interventions, including shared regional templates, a knowledge hub to translate requirements into practice, role-specific training emphasising applied competence, and digital support for validation and assurance, measures intended to reduce interpretive burden and improve consistency across the supply chain.*

KEYWORDS: *building information modelling (BIM), ISO 19650, BIM governance, non-mandated adoption, information management.*

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1. INTRODUCTION

Building Information Modelling (BIM) has become a core approach to digital delivery in the construction industry, supporting integrated project delivery, improved collaboration, and structured information management across the asset lifecycle (Tran & Nguyen, 2024). The internationalisation of BIM practice through standards, most notably the ISO 19650 series, has further shifted attention from modelling as a software capability to information management as an organisational and project governance function. As BIM adoption has expanded across public and private markets, implementation pathways have diverged. Some jurisdictions have pursued top-down adoption through government mandates and accompanying guidance, whereas others have progressed through bottom-up, market- and client-led diffusion (Hussain et al., 2024). These differing trajectories suggest that mandates may accelerate uptake, but they do not by themselves ensure consistent, standard-aligned practice. Instead, BIM governance, defined here as the roles, responsibilities, processes, and assurance mechanisms that translate standards into operational workflows, is repeatedly identified as a determinant of implementation quality across regulatory contexts.

Wales, a devolved region within the United Kingdom, provides a salient context for examining BIM and ISO 19650 implementation where there is no devolved BIM mandate, no sustained programme funding, and no single coordinated implementation framework. In contrast to England, where the 2011 UK Government Construction Strategy required Level 2 BIM for centrally funded projects (Mitera-Kiełbasa & Zima, 2024), BIM adoption in Wales has largely emerged through voluntary and decentralised initiatives. This context creates both flexibility and risk. Contractors and local authorities must interpret and operationalise standards such as ISO 19650 with variable client capability, inconsistent commissioning practices, and limited access to shared templates and guidance. The result, as suggested in prior work on under-mandated environments, can be fragmented implementation and unclear accountabilities (Munir et al., 2020). However, longitudinal evidence on how governance can be strengthened in such settings remains limited.

This study treats the absence of a mandate not only as a constraint but also as an analytical opportunity to examine how bottom-up governance is constructed, where it fails, and what enabling infrastructure is most likely to improve consistency. The study asks how Welsh organisations interpret and enact ISO 19650 in practice, and what supports, templates, training pathways, digital checking/assurance tools, and shared frameworks could reduce interpretive burden and improve standards alignment without legislative enforcement. Using a mixed-methods design that integrates stakeholder workshops, semi-structured interviews, and a structured survey of contractors and local authorities, the paper situates the Welsh case within international debates on mandated versus non-mandated adoption.

Methodologically, the research adopts a longitudinal case study design, positioning Wales as a cautionary and instructive case rather than an exemplar. As a devolved region with regulatory and cultural proximity to England but without equivalent mandate infrastructure, Wales offers a meaningful contrast for examining how governance conditions influence implementation outcomes. The seven-year study period (2017-2023) supports analysis of persistence and path dependency in governance challenges, patterns that may be obscured in cross-sectional studies.

To support analytical precision, two terms are distinguished. “BIM usage” refers to reported use of BIM tools on projects, without implying compliance with any standard. “Standards-aligned implementation” refers to the formal adoption and operationalisation of ISO 19650 (and/or legacy PAS 1192 practices where relevant), typically evidenced through defined information requirements (e.g., EIRs/AIRs), delivery planning documentation (e.g., BEPs, MIDPs, TIDPs), and a Common Data Environment (CDE) that supports the information management process. This distinction is critical because high tool uptake can coexist with weak governance and inconsistent information management.

The paper is structured as follows: Section 2 provides a literature review on BIM adoption models, the ISO 19650 framework, and BIM governance, including international comparisons with both mandated and non-mandated regions. Section 3 outlines the research methodology, including rationale for data collection methods and thematic analysis. Section 4 presents the findings from workshops, interviews, and questionnaires, highlighting key challenges and governance gaps. Section 5 discusses the implications of these findings, contrasts them with international practices, and proposes solutions for improving BIM governance in under-mandated settings. Section 6 offers conclusions and recommendations for policy, practice, and future research.

2. LITERATURE REVIEW

2.1 BIM adoption across governance contexts

The global adoption of BIM is shaped by interacting influences, including policy direction, market incentives, industry capability, procurement practices, and governance arrangements. Although early diffusion was often associated with government-led mandates, recent scholarship emphasises that implementation success is not exclusive to top-down regulation. Both mandated and non-mandated environments can achieve progress, but typically through different pathways, reinforcing BIM governance as a key enabling condition for digital transformation in the built environment (Rinchen et al., 2024).

Mandated contexts have commonly combined compulsory requirements for publicly funded projects with guidance, capability-building, and supporting institutions. In the UK, the 2011 Government Construction Strategy required Level 2 BIM for central government projects by 2016 (Mitera-Kiełbasa & Zima, 2024), supported by guidance and standards that shaped market expectations. However, it is important to distinguish between (i) the policy requirement and (ii) the specific supporting documents that were used at the time. For example, the PAS 1192 suite, including PAS 1192-2:2013, which BSI records as published in 2013 and withdrawn in 2019, provided a widely used precursor framework that informed UK practice prior to the internationalisation of the approach through ISO 19650. Similar mandate-led trajectories are reported in other jurisdictions. Singapore's Building and Construction Authority required BIM for specified regulatory submissions from 2015 (Namlı, 2024). Finland's national BIM requirements (COBIM), promoted through Senate Properties, are frequently cited as a benchmark for structured digital delivery. In such contexts, mandates can reduce uncertainty by clarifying expectations, aligning procurement signals, and supporting training and guidance, though uneven maturity and variable execution remain widely reported (Panagiotidou et al., 2022).

In contrast, non-mandated or decentralised contexts have progressed through combinations of client leadership, competitive pressures, and sectoral coordination. In the United States, BIM uptake has been driven largely by major private clients and federal agencies (e.g., GSA and USACE), rather than a single national mandate (Jiang et al., 2022). Germany has pursued a staged approach that combined pilots and coordination initiatives (e.g., Planen-Bauen 4.0 and the "Stufenplan Digitales Planen und Bauen"), alongside movement toward requirements for federal infrastructure delivery from 2020 (McAuley et al., 2017). Australia's adoption has also been shaped by state-level leadership and industry initiatives, producing uneven implementation across sectors and client types. These cases indicate that mandates are not a prerequisite for BIM diffusion; nevertheless, in the absence of a mandate, governance mechanisms that standardise roles, processes, and deliverables become more, not less, important to reduce fragmentation and rework.

Across both governance contexts, the effectiveness of BIM implementation depends heavily on the presence and quality of governance mechanisms: the formal and informal structures that support consistency, accountability, and alignment among stakeholders. Governance includes formal elements (e.g., standards, contracts, assurance/audit practices) and informal elements (e.g., leadership, learning cultures, training provision). Without such mechanisms, even mandated environments report uneven implementation, misaligned expectations, and fragmented data management (Succar, 2009; Antwi-Afari et al., 2018; Whitlock & Abanda, 2020). In non-mandated settings, the lack of enforcement increases the importance of internal and regional coordination mechanisms that help organisations interpret standards, standardise documentation, and embed information management into delivery workflows. This is particularly relevant for ISO 19650, which provides an information management framework but leaves significant discretion in operationalisation, discretion that can produce inconsistency when capability and guidance are uneven.

Within this landscape, Wales occupies a distinctive position. It shares regulatory and professional proximities with England but lacks equivalent mandate infrastructure, creating the conditions to examine how BIM and ISO 19650 are interpreted when adoption is primarily voluntary. Rather than assuming that mandate absence determines outcomes, the Welsh case enables examination of how governance capacity (e.g., templates, training, commissioning competence, and assurance practices) mediates the translation of standards into routine practice.

2.2 Information management and ISO 19650

Effective information management across the built asset lifecycle is a central component of digital transformation

in construction. As projects become more data-intensive, structured and accessible information is needed to support quality, interoperability, and long-term asset performance. The ISO 19650 series, developed as an international evolution of earlier UK approaches associated with the PAS 1192 standards, provides a globally recognised framework for information management using BIM (Malla, Tummalapudi and Delhi, 2024).

A persistent implementation challenge is defining meaningful information requirements. Organisational Information Requirements (OIRs) and Asset Information Requirements (AIRs) require alignment between organisational objectives and asset management needs, yet many public-sector clients struggle to articulate these requirements in ways that are operationally actionable. Prior studies report that where OIRs are unclear or absent, downstream information delivery can become fragmented, redundant, or misaligned with organisational value drivers (Saleeb, 2019; Heaton et al., 2019). Exchange Information Requirements (EIRs), intended to specify what information is required, when it is required, and in what form, also vary widely in quality. In the absence of shared templates and authoritative examples, bespoke EIRs are commonly produced, increasing transaction costs and creating avoidable variability across projects and supply chains (Whitlock & Abanda, 2020).

ISO 19650 is deliberately flexible and scalable, but this flexibility can amplify inconsistency where resources and competence are limited. This is especially evident for SMEs and public authorities that may lack the staff capacity, training, or digital infrastructure required to operationalise the standard effectively. Commonly cited barriers include limited client understanding, uncertainty about requirements, and a lack of practical support tools that translate the standard into step-by-step delivery practices (Al-Mohammad et al., 2022; Panagiotidou et al., 2022).

A further governance challenge concerns the use of ISO 19650 planning and delivery documentation. Documents such as BEPs, MIDPs, and TIDPs are frequently treated as administrative outputs rather than as living coordination instruments embedded in routine workflows. Where project assurance mechanisms are weak, documentation can become decoupled from practice: produced to demonstrate nominal compliance but not used to govern information delivery (Succar, 2009; Whitlock & Abanda, 2020). Integration with established project-stage frameworks (e.g., the RIBA Plan of Work) can also be challenging where information delivery cycles and role definitions do not align cleanly with existing procurement and project management routines. These frictions reinforce the need for "translational" governance supports, templates, worked examples, and checking/assurance routines, that make ISO 19650 implementable rather than merely interpretable.

2.3 BIM maturity models and frameworks

BIM maturity is commonly used to assess the extent to which digital construction practices are embedded within organisations and projects. Maturity models typically evaluate capability across people, process, and technology, supporting benchmarking and structured improvement planning. As BIM practice evolves from tool-centric adoption toward integrated information management, maturity assessments increasingly function as proxies for organisational readiness and governance effectiveness.

A foundational contribution is the Succar BIM Framework (Succar, 2009), which conceptualises maturity across fields (Technology, Process, Policy), stages (from pre-BIM to integrated BIM), and evaluation lenses. While influential, the framework remains relatively high-level and provides limited operational guidance for assessing standards-aligned information management practices, particularly those associated with ISO 19650. More recent syntheses, such as Sun et al. (2021), classify maturity models into progressive stages of integration, but similarly note that many tools focus on general capability rather than standards-specific operationalisation.

Several widely cited assessment tools illustrate both utility and limitations. The Penn State BIM Maturity Model evaluates six dimensions (Strategy, Infrastructure, Information, Process, Personnel, Culture) across a maturity scale (Penn State University, 2012). The Arup BIM Maturity Tool adapts similar logic into a practical checklist format (Arup, 2014). QuickScan (Sebastian and Van Berlo, 2010) provides a multi-domain organisational benchmark, including legal aspects and open standards. The NBIMS Capability Maturity Model offers extensive domain coverage but has been criticised for complexity and limited accessibility for smaller organisations (McCuen et al., 2012). The Cambridge Maturity Assessment Tool (2018) supports collaborative assessment in a UK context but is not designed as a direct ISO 19650 compliance instrument.

Across these models, several limitations become apparent when maturity is viewed through an ISO 19650 governance lens. First, many models lack explicit alignment to ISO 19650 concepts and deliverables, limiting their usefulness for organisations seeking standards-aligned implementation rather than generic capability

benchmarking. Second, granularity is often insufficient for diagnosing workflow-level weaknesses in requirements definition, delivery planning, approval/status processes, and CDE-based information control. Third, many models rely heavily on self-assessment, introducing bias where external validation and comparable benchmarks are absent. Finally, governance and commissioning capability, particularly client-side competence in defining and assuring information requirements, tends to be underrepresented relative to technology and modelling capability.

In non-mandated contexts such as Wales, maturity assessment therefore needs to extend beyond software proficiency to capture the capacity to define, commission, and assure information delivery in line with ISO 19650 principles. Governance-oriented maturity indicators include the availability and use of standard-aligned templates, clearly assigned and empowered roles, training programmes that build applied competence, and digital tools that support validation and monitoring of deliverables (Antwi-Afari et al., 2018; Munir et al., 2020). Accordingly, this study contributes to the literature by examining BIM maturity in Wales as a function of governance capacity and institutional readiness, rather than treating maturity as primarily a technical construct.

3. METHODOLOGY

This study adopts a governance-oriented, qualitative-dominant mixed-methods approach to examine BIM and ISO 19650 implementation dynamics in the Welsh construction sector. The absence of a devolved BIM mandate, centralised programme funding, or a coordinated regional implementation framework in Wales provides an opportunity to examine how BIM standards are interpreted, operationalised, and governed when adoption is driven by voluntary, decentralised processes. The study addresses four research questions:

1. What challenges do stakeholders face in implementing BIM and complying with ISO 19650 in the absence of a mandate?
2. What are the key weaknesses in governance structures, documentation, and process alignment that delay effective implementation?
3. How do contractors and local authorities interpret and enact their roles in the BIM delivery process?
4. What governance strategies, tools, or support mechanisms could enhance BIM implementation in decentralised settings?

These questions are informed by a governance lens that considers both formal structures (e.g., standards, documentation, contractual roles, assurance practices) and informal practices (e.g., leadership, training, coordination norms). This framing is consistent with a constructivist orientation in which standards implementation is shaped by organisational context, professional interpretation, and project constraints. A qualitative-dominant design was therefore selected to capture stakeholder experiences and sensemaking, supported by quantitative survey data to test the salience of emergent themes across a broader respondent group.

3.1 Research design and data collection

The research employed a three-method triangulation strategy consisting of workshops, semi-structured interviews, and a structured questionnaire. These methods were selected for complementarity: workshops supported collective reflection and surfacing of shared issues; interviews provided depth and case-based detail; and the questionnaire provided breadth across organisations. Figure 1 summarises the overall design and how data collection and analysis stages interrelate.

A total of ten workshops were conducted between 2017 and 2023 with local authorities, framework managers, and contractors across Wales. Of these, three workshops were selected for detailed analysis because of their thematic alignment with the study focus (BIM implementation, asset handover, and standards compliance). Participants included public-sector digital leads, procurement officers, and Tier 1 and Tier 2 contractors. Design-side professionals (e.g., architects and engineers) were not directly sampled; however, workshop discussions frequently referenced design-stage constraints and interface issues, which are treated as contextual rather than primary evidence. Each workshop followed a semi-structured format combining short presentations on BIM standards (including ISO 19650), demonstrations of relevant tooling (e.g., COBie-related platforms), and facilitated breakout discussions. Ethical approval was granted by Cardiff University; participants provided informed consent. Field notes were taken throughout, and audio recordings were made where permission was granted.

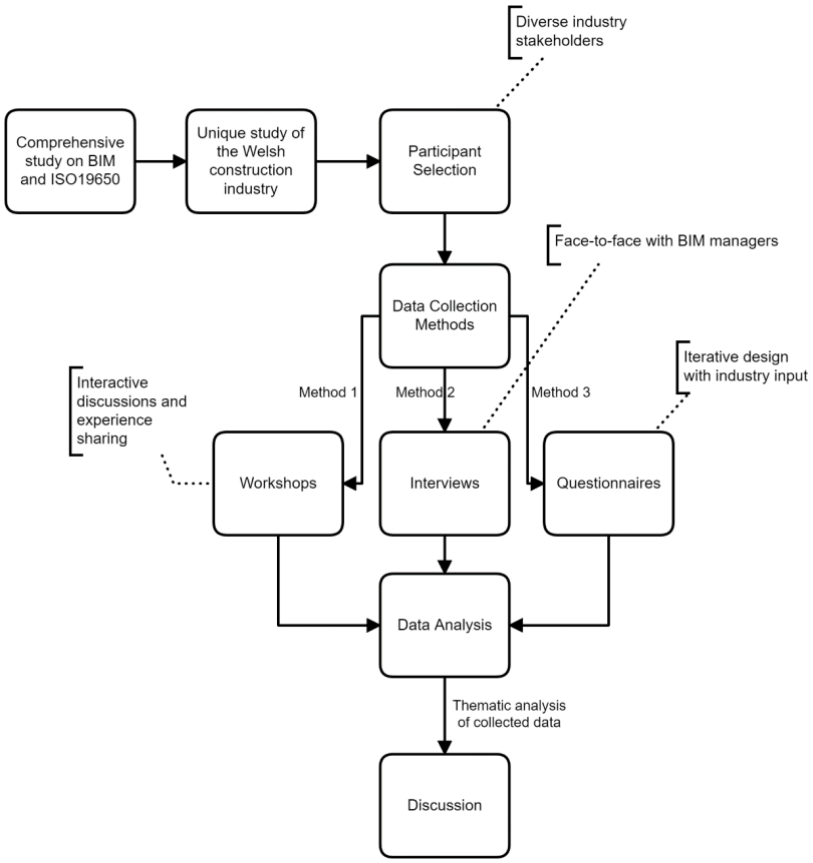

Figure 1: Research Methodology.

3.2 Thematic analysis process

Thematic analysis followed the six-phase process outlined by Braun et al. (2023): (1) familiarisation, (2) initial coding, (3) generating themes, (4) reviewing themes, (5) defining/naming themes, and (6) narrative synthesis. Coding was initially inductive to allow patterns to emerge from workshop and interview data. These codes were then refined deductively using sensitising concepts from the literature on BIM governance and ISO 19650 implementation. Themes, including client commissioning capability, documentation practices, process fragmentation, perceived value of certification, and information-requirements alignment, were retained based on recurrence and relevance to the research questions.

To strengthen trustworthiness, the analysis prioritised (i) triangulation across workshops, interviews, and survey responses; and (ii) the use of direct quotations to evidence interpretive claims. (Detailed steps for coder roles and agreement are reported as part of the analysis protocol; where single-coder interpretation is used, this is stated explicitly in reporting.)

3.3 Interviews

To supplement workshop findings with individual organisational perspectives, four semi-structured interviews were conducted with BIM managers and digital leads from Tier 1 and Tier 2 contractors in Wales. Organisations were selected to reflect variation in reported maturity (including certified and non-certified organisations). Interviews began with the open-ended prompt:

"Tell me about your experiences in implementing BIM and your understanding of BIM standards."

This prompt enabled participants to foreground issues they considered salient while maintaining comparability across interviews. Transcripts were analysed using the same thematic framework as the workshops to support cross-method integration.

3.4 Questionnaire design and distribution

To validate and extend qualitative findings, a structured questionnaire was developed with industry input. The design followed best-practice guidance for survey construction and administration (Dillman et al., 2014; Fowler, 2013) and was refined through two feedback cycles during workshops. The final instrument included multiple-choice items, Likert-scale questions, and open-ended prompts covering: awareness of ISO 19650, use of BIM documentation (e.g., BEPs, EIRs, COBie-related deliverables), training and capability, perceptions of governance effectiveness, and implementation challenges and support needs. The questionnaire was designed to support triangulation rather than population estimation; results are interpreted as indicative of the sampled groups.

The survey was distributed to 29 contractors active on public-sector frameworks and hand-delivered to 19 local authority representatives at a regional construction event. A total of 42 valid responses were collected (23 contractors; 19 local authority staff). Figure 2 outlines the data collection sequence and stakeholder pathways.

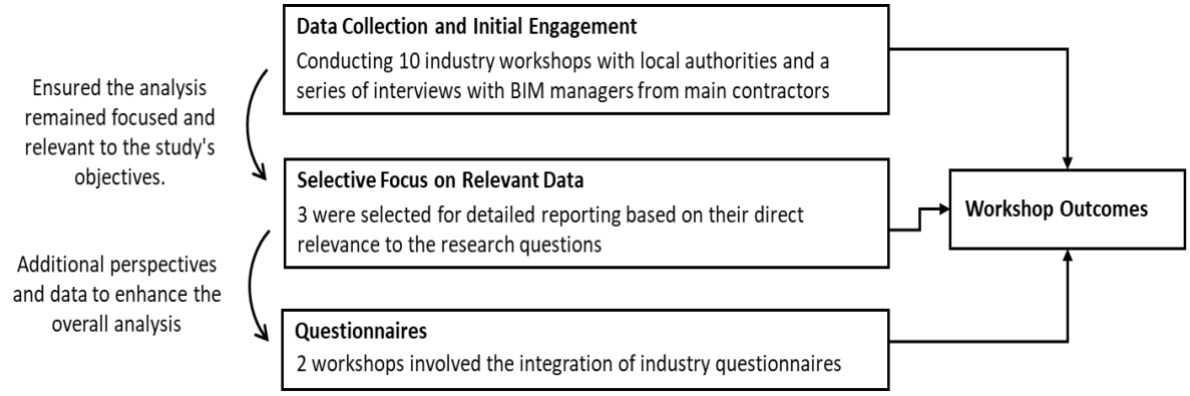

Figure 2: Data collection process.

3.5 Ethical considerations and limitations

All research activities complied with Cardiff University ethical protocols. Participants were informed of the study aims, assured of anonymity, and could withdraw at any time. Data were stored and reported in accordance with data protection requirements. The study acknowledges limitations. The exclusion of design-side professionals may reduce insight into early-stage requirement-setting and design coordination practices. This was a deliberate choice to focus on delivery-side governance, where ISO 19650 processes are operationalised through commissioning, documentation, assurance, and handover. A further limitation is the modest interview sample size and the context-specific nature of the case; accordingly, the study makes analytic (theory-informed) rather than statistical generalisations. Future research should expand the stakeholder base to include designers, facilities managers, and asset owners to test whether the same governance constraints persist across lifecycle phases.

4. FINDINGS

4.1 Workshop findings: Governance challenges in a non-mandated landscape

The workshop data revealed a consistent pattern of governance-related challenges affecting BIM and ISO 19650 implementation across the Welsh construction sector. While participants recognised the strategic benefits of structured information management, they expressed widespread frustration with the practical realities of applying standards in the absence of clear guidance, leadership, or enforcement. The lack of a national BIM mandate in Wales has resulted in significant variability in how public sector clients and contractors interpret and operationalise BIM requirements. The following themes emerged across the three workshops, each reflecting a distinct governance challenge and opportunity. Figure 3 visualises the range of roles represented across the workshops.

A dominant theme concerned client-side capability and commissioning practice, particularly within local authorities. Participants reported that appointing parties often lacked the technical and procedural competence to define project-specific EIRs. EIRs were repeatedly characterised as recycled or overly generic, creating downstream uncertainty. As one contractor stated:

"We get EIRs that are either copied from old projects or so generic they're useless. Then we're expected to somehow make it all compliant."

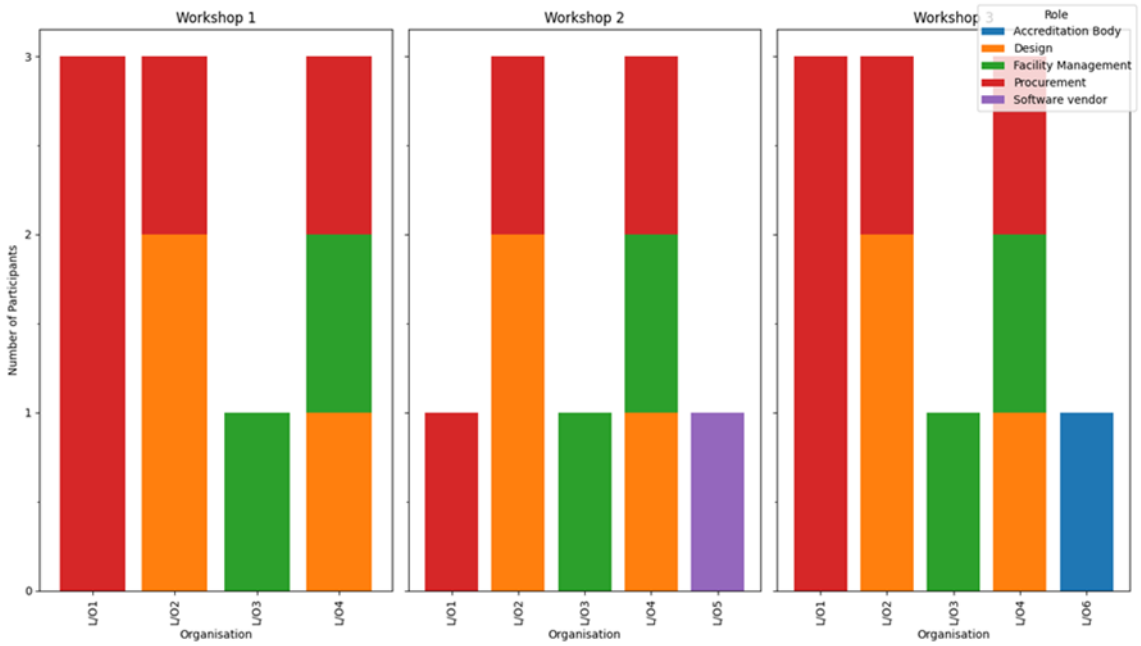

Figure 3: Roles and organisational affiliation of participants in Workshops 1-3.

This perceived lack of commissioning clarity shifted interpretive and coordination burdens to contractors and digital leads, contributing to inconsistent information deliverables.

A second theme concerned the administrative burden and limited operational use of documentation. Participants discussed the effort involved in producing BEPs, MIDPs, and COBie-related deliverables, but emphasised that these artefacts were not consistently embedded in project control routines. Documentation was frequently framed as produced for compliance rather than coordination. One attendee remarked:

"So much of the documentation is just done to tick a box. It's not actually used to manage the project."

A third theme was fragmentation across stages and stakeholder groups, particularly in handover. Participants described siloed processes in which COBie outputs were often delivered as static spreadsheets late in delivery, with limited integration into asset management practices. This disconnect was attributed to structural and cultural barriers, including ambiguous role definitions, procurement silos, and limited cross-organisational workflows. These workshop accounts indicate a recurring misalignment between ISO 19650's lifecycle-oriented intent and the way information is commissioned, produced, and transferred in practice.

Importantly, participants did not frame these issues solely as a consequence of non-mandated policy conditions. Rather, they emphasised the absence of shared enabling infrastructure, such as standardised templates, practical worked examples, and checking/assurance tools, that could make consistent delivery more feasible. One participant summarised this as:

"We don't need a mandate - we need a map. Give us a structure and we'll follow it."

Across workshops, participants expressed strong interest in a publicly available "starter pack" comprising aligned templates (EIRs, BEPs, MIDPs, COBie-related outputs) and in regional support mechanisms that could reduce duplication and uncertainty. Suggested interventions included: (1) a regional BIM coordination body or knowledge hub; (2) automated checking for COBie and document compliance; and (3) role-specific training pathways and peer-learning networks in the public sector. Table 1 summarises themes across Workshops 1-3.

Table 1: Themes identified during Workshops 1, 2 and 3.

	Main Theme	Sub-themes	General comments
Workshop 1	Implementation	Software	• Revit is noted for its high cost. • A preference for shifting BIM-related costs to contractors.
		Project status	• BIM's efficacy in tracking project progress is questioned.
		Training and Skills	• A lack of understanding of BIM's core concepts is common.
		Understanding	• BIM is considered too time-consuming and complex.
		Standards	• Difficulty in applying BIM standards, with standards seen as beneficial only if they are well-understood
	Managing BIM	Standards	• The need for continuing BIM management is recognised.
		BIM Meetings	• BIM meetings are dominated by contractors' agendas.
		Model quality	• Ensuring the accuracy of BIM model coordinates is a challenge.
		Clash detection	• The value of clash detection in preventing construction issues is recognised.
		Contractors	• There is uncertainty about contractors' compliance with BIM standards.
	Facilities Management (FM)	Handover Data	• COBie is poorly understood and often oversimplified.
		Training & Skills	• The fixed use of paper poses barriers to digital adoption in FM.
		Understanding	• Doubts are cast on BIM's value for FM.
		Requirements	• Aligning asset requirements with standards raises questions of compliance. The standard's guidance on managing asset requirements remains unclear.
	Legal issues	BIM protocol	• There is a discernible need for legal guidance on the implications of BIM adoption.
	Document production	Requirements	• Clarifying the precise document production requirements, including alignment with other standards, is required.
		Templates	• The demand for standardised document templates reflects a pursuit of consistency. There is an appeal for a universally applicable template within the standard.
		BEP	• The necessity and contractual inclusion of a BEP require a more explicit legal definition.
Workshop 2	Facilities Management (FM)	Handover Data	• Challenges are noted in acquiring the correct information from contractors. Software is anticipated to facilitate BIM usage.
		Training & Skills	• Scepticism exists regarding the ease of software use, with anticipated technical issues. Training is recognised as a key factor for effective software utilisation.
		Understanding	• FM departments are perceived as unlikely to use BIM and deemed unnecessary. • Doubts are cast on BIM's applicability to existing structures within FM practices.
		Requirements	• The need to define specific information requirements for FM
		Cost	• Anticipation of long-term cost savings is coupled with high initial investment expectations.
Workshop 3	Implementation	Software	• A desire for software to simplify BIM management is expressed.
		Project status	• Standards are not seen as helpful in indicating project progress.
		Training and Skills	• Time constraints on additional BIM training are stressed. • Interest is shown in organising targeted framework training.
		Understanding	• Clarification is required on whether using Revit equates to implementing BIM.
		Costs	• Inquiry about cost reduction via adherence to standards is made. • There is a need for consultancy services to understand BIM.
	Managing BIM	Standards	• Standards are recognised as improving project management and unifying stakeholders.
		BIM Meetings	• No comments were provided.
		Model quality	• Questions about the integration of BIM models are posed.

Main Theme	Sub-themes	General comments
	Clash detection.	• Clash detection's exclusion from standards and its potential as an add-on is discussed. • Inquiry about a specific standard for clash detection is made.
	Contractors	• Contractor adherence to a uniform standard is proposed to be sensible.
Facilities Management	Handover Data	• The connection between handover data standards and software is not fully understood.
	Training & Skills	• No comments were provided.
	Understanding	• Standards are agreed to encompass the project lifecycle, prompting questions about model handover to FM.
	Requirements	• Compliance through accurate asset requirements is queried. • Guidance on managing requirements per the standard is required.
Document production	Requirements	• Acknowledge the need for comprehensive documentation beyond the EIR. • Concerns about producing and verifying contractor documentation surface. • The time burden of document creation for numerous projects is noted. • Difficulty in understanding and writing an EIR is expressed.
	Templates	• Interest in standard-provided templates for documentation is indicated. • Clarification on aligning Asset Information Requirements with other standards is requested.
	BEP	• No comments were provided.

4.2 Interview findings: Individual perspectives on BIM governance

The semi-structured interviews provided detailed accounts of how BIM and ISO 19650 are interpreted, implemented, and governed within contracting organisations in Wales. Overall, interview narratives reinforced workshop themes, particularly around commissioning, documentation, and role clarity, while adding project-level examples of how governance gaps are managed in practice.

A central concern was role and accountability ambiguity, especially where client direction was limited. Interviewees described being expected to compensate for vague or recycled EIRs and to "fill in" missing commissioning detail. One digital lead stated:

"We end up writing the EIR ourselves half the time. The client signs off, but they don't really understand what's in it."

Interviewees also highlighted the disconnection between documentation and workflow. BEPs and related deliverables were often described as static artefacts that were agreed early but not systematically used to govern day-to-day information exchange. As one participant put it:

"Our BEP is a static document that gets signed off at the start and then ignored."

A further theme was uneven interpretability of ISO 19650. Although participants were familiar with the standard, they described differing levels of confidence in translating it into executable procedures, particularly without external support or examples. One interviewee noted:

"It's a good standard, but it's written in a way that assumes you already know what you're doing."

This supports the need for translational governance supports (annotated templates, worked examples, walkthroughs) to bridge the gap between standard text and operational practice.

Finally, interviews underscored a perceived mismatch between certification/training and applied competence. Participants reported that formal credentials did not necessarily translate into the ability to produce or assure key deliverables such as TIDPs or COBie checks:

"We've got people with BIM certificates who still don't know how to write a TIDP or check a COBie file."

Interviewees did not present a mandate as a necessary condition for improvement. Instead, they reiterated workshop proposals for sector-led governance supports: a knowledge hub, shared templates, and automation to support validation and reduce manual checking burdens. Table 2 summarises themes across the four interviews.

Table 2: Thematic analysis of interviews 1-4.

	Main Theme	General comments
Interview 1	Implementation	• Standards are perceived as complex, leading to implementation difficulties. • Clients' needs are frequently misinterpreted. • Transition observed from traditional methods to exclusive BIM usage.
	Client	• Client engagement with PAS1192 standards appears to be lacking. • Clients' EIRs are often deemed insufficient.
	Models	• Incorporation of clash detection within the workflow is acknowledged. • On-site BIM-Server usage is reported, albeit with operational issues. • Incompleteness of models during the construction phase is noted.
	Process	• Engagement of external consultants to refine BIM procedures is stated. • Inconsistency in supply chain adherence to a unified process is noted. • Suggestions for more streamlined PAS1192/ISO19650 documentation are proposed.
	Documents	• Creation of a basic BEP is noted, yet compliance is compromised by client misunderstanding. • Tender assumptions contribute to document discrepancies.
Interview 2	Implementation	• Repeated experiences have fostered a streamlined adoption of BIM.
	Client	• The EIR provided by the client is inadequate. • The client shows a limited scope of the necessity of BIM deliverables. • The client's preference for non-standard BIM practices results in confusion.
	Models	• The adoption of 3D BIM, which focuses on geometric dimensions, is a recent development. The integration of 4D BIM, which integrates time-related data, has not been initiated.
	Process	• The absence of a formalised process leads to overlooked steps. • Despite certification, compliance with mandatory practices is inconsistent. • Procedures for the supply chain lack standardisation
	Documents	• The BEP is developed to a satisfactory standard. • Subpar EIR leads to an increased reliance on assumptions. • Documentation practices are inadequate, with the BEP being the exclusion. • The application of zones within the BEP deviates from standard principles. • There is a recurring issue with the incorrect numbering of documents.
Interview 3	Implementation	• The contractor experiences minimal challenges with BIM standards, demonstrating effective implementation. • BIM certification is seen as beneficial, enhancing client confidence. • Plans are in place to adopt new BIM standards. • The contractor rates their understanding of BIM standards as mature.
	Client	• A focus is placed on realising client needs and sustaining service delivery. • Efforts are concentrated on facilitating smoother BIM transitions for clients.
	Models	• The contractor maintains in-house BIM modelling expertise. • Exploration into the integration of 4D BIM is underway. • A virtual reality setup has been established to involve clients more deeply. • Challenges persist with setting appropriate clash detection tolerances.
	Process	• The contractor acknowledges the need for growth in their process and classification definitions. • A clearly defined process and reporting structure are currently lacking. • An absence of a standardised method for communicating project stages.
	Documents	• A singular set of document templates is utilised and tailored to individual project requirements. • Templates are adapted to include client EIRs, compensating for clients' lack of provision. • Manual checks remain necessary to ensure document accuracy.
Interview 4	Implementation	• Standards are implemented effectively, and no significant challenges have been reported. • Certification is deemed valuable, fostering greater client trust. • A new standard is slated for internal rollout at the head office. • The contractor claims a well-developed understanding of BIM standards.
	Client	• Efforts are underway to enhance client engagement with BIM processes. • Adopting a gradual approach to BIM transitions is anticipated to benefit clients.

Main Theme	General comments
Models	• The contractor possesses robust in-house modelling capabilities. • Initiatives to incorporate 4D BIM are in progress. • A VR setup is available to clients for model visualisation. • Issues with clash detection tolerances are persistently encountered.
Process	• Maturity in process classification and definition is recognised as an area for growth. • The absence of established processes and reporting mechanisms is noted.
Documents	• Project-specific customisation of document templates is a standard practice. • Templates are designed to integrate client EIRs, although clients often do not supply these. • Manual verification of document precision remains a prerequisite.

4.3 Synthesis of qualitative findings: Governance themes across data sources

Integrating evidence from the workshops and interviews reveals four cross-cutting governance themes. First, participants consistently reported weaknesses in commissioning practice. Appointing parties,. particularly local authorities, were described as frequently issuing vague, generic, or recycled EIRs. This shifts the interpretive burden onto delivery teams, increases variation in how requirements are understood, and ultimately reduces consistency and comparability of information outputs downstream. Second, the data indicate a recurring decoupling between compliance and performance. BEPs, COBie-related deliverables, and other planning documents were often treated as "tick-box" artefacts produced to satisfy formal requirements rather than as live coordination tools that actively shape delivery behaviours, information quality, and decision-making.

Third, role ambiguity emerged as a persistent issue. Digital responsibilities were often unclear both contractually and organisationally, and digital leads commonly reported limited authority to enforce governance practices across internal teams and multi-tier supply chains. This constrains accountability and makes it difficult to embed consistent processes, even where individuals recognise what "good" looks like. Fourth, participants described inconsistent interpretation of the standard in practice. Core ISO 19650 concepts, such as information requirements, delivery planning, and CDE controls, were applied variably across projects and organisations. This variation points to a need for translational aids and practical guidance that bridge the gap between standardised language and on-the-ground implementation.

Despite these challenges, both evidence sources indicated a strong appetite for improvement through enabling mechanisms rather than legislative enforcement. Respondents emphasised the value of practical templates, shared learning infrastructure, and validation or assurance support to improve clarity, build capability, and drive more consistent application of ISO 19650 across the sector.

4.4 Surevey results

The structured questionnaire was designed to validate and extend qualitative findings by capturing wider perspectives on BIM and ISO 19650 (and/or PAS 1192) implementation in Wales. A total of 42 valid responses were received (23 contractors; 19 local authority representatives). The survey targeted stakeholders involved in digital delivery and information management, consistent with the study's delivery-side governance focus. Figure 4 summarises respondent characteristics, including professional memberships, BIM tool usage, and standards implementation.

Reported BIM usage was high: 88% of respondents indicated that they currently use BIM, while 12% reported that they do not. However, reported standards implementation was lower. Only 29% of respondents reported implementing either ISO 19650 or PAS 1192, while 71% reported implementing neither. These survey results are interpreted within the scope of this study and instrument: they establish a within-sample contrast between tool usage and reported standards-aligned implementation, rather than serving as a benchmark against other countries or as a population estimate.

Disaggregation by respondent group sharpened this pattern. Among local authority respondents ($n = 19$), none reported implementing PAS 1192 or ISO 19650 in the terms used in the questionnaire; among contractors ($n = 23$), half reported implementation. While subgroup sizes are modest and should be interpreted as indicative, the difference aligns with the qualitative evidence that commissioning capability and requirements definition are persistent constraints on standards-aligned information delivery.

Taken together, the survey corroborates the qualitative pattern: Wales appears to be a sector with substantial BIM tool uptake but comparatively lower reported uptake of standards-aligned information management practices, consistent with the study's framing of a governance maturity gap.

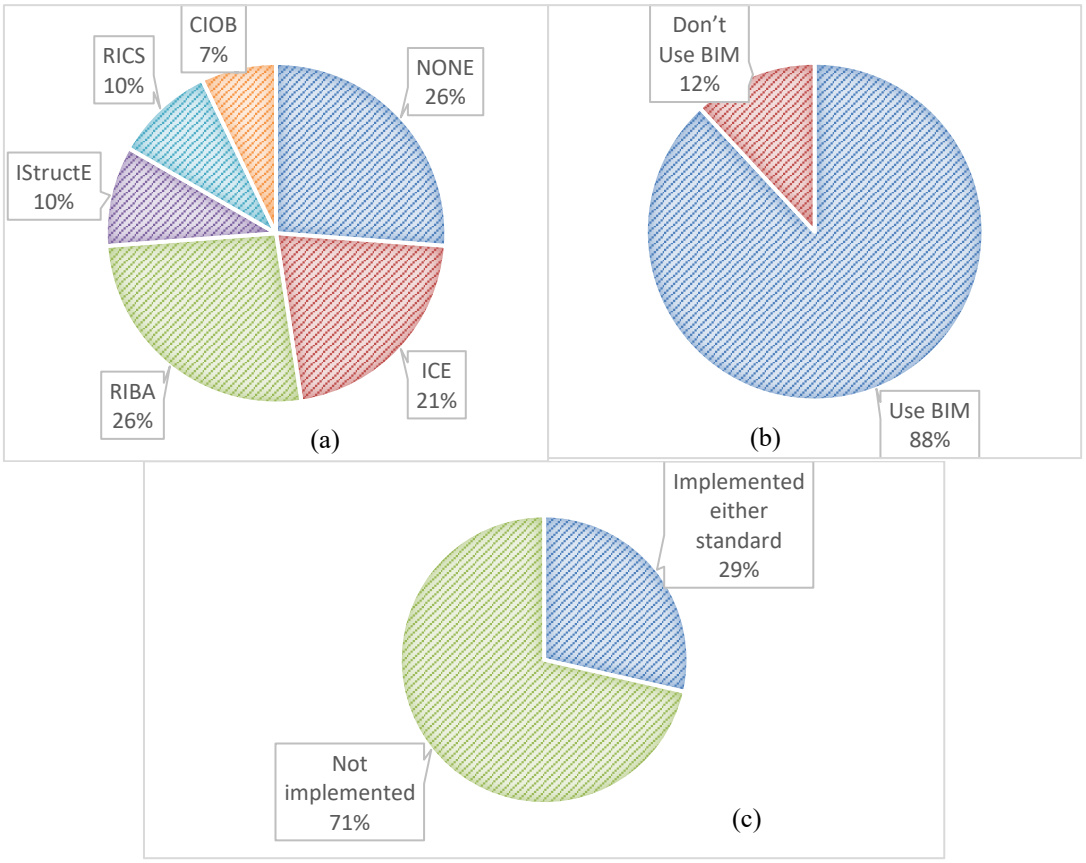

Figure 4: (a) Professional memberships; (b) BIM use among respondents; (c) Implementation of BIM standards (ISO 19650 and PAS 1192).

5. DISCUSSION

Triangulation across workshops, interviews, and the survey supports a consistent interpretive conclusion: in Wales, the observed gap between widespread BIM tool use and comparatively low reported standards-aligned implementation is explained primarily by governance conditions, not by the availability of technology. The evidence indicates three interrelated mechanisms that together constrain ISO 19650-aligned information management in a non-mandated landscape.

ISO 19650 presumes that the appointing party defines clear, project-specific information requirements early enough to structure delivery planning and information production. In this study, however, commissioning practice was repeatedly characterised as weak. Quantitatively, no local authority respondent in the survey reported implementing ISO 19650 or PAS 1192 in the terms captured by the questionnaire, while qualitative accounts described EIRs as routinely vague, recycled, or absent. As a result, responsibility is effectively inverted: contractors and digital leads reported having to interpret, reconstruct, or even author information requirements to enable delivery. This inversion is not simply inefficient; it disrupts the collaborative governance logic of ISO 19650 by relocating decision-making and definition of "required information" away from the appointing party. The downstream consequence is predictable variability: if requirements are unstable or generic at the point of appointment, consistency cannot be reliably achieved across BEPs, delivery plans, model outputs, and handover data.

A second mechanism is the decoupling of formal documentation from operational practice. Across data sources, BEPs, MIDPs and COBie deliverables were frequently described as compliance artefacts produced to satisfy

contractual expectations rather than as active coordination instruments embedded in day-to-day workflows. This is a governance failure rather than a documentation failure: where projects lack assurance routines (e.g., iterative checking, clear acceptance criteria, auditability, and feedback loops), documents can be "completed" without changing behaviour. In this setting, compliance becomes performative, masking dysfunction rather than correcting it. Importantly, participants did not reject the logic of ISO 19650 itself. Instead, they repeatedly pointed to the absence of enabling infrastructure that would make the standard actionable in routine delivery: practical templates, worked examples, and validation tools (particularly for COBie and document quality). In other words, the standard exists, but the translation layer that connects it to everyday project management remains underdeveloped.

The third mechanism is role ambiguity across procurement, delivery, and handover. Participants described digital responsibilities as weakly specified contractually and inconsistently governed organisationally. Digital leads were often tasked with ensuring compliance but lacked the authority, time, or organisational leverage to enforce it across supply chains. This governance gap was further compounded by training and accreditation pathways perceived to prioritise certification over applied competence, a theme explicitly raised in interview accounts.

Role ambiguity helps explain why information management practices remain inconsistent even when individuals are motivated to improve: capability is unevenly distributed, and accountability is not systematically anchored in procurement structures or organisational reporting lines. These mechanisms, commissioning weakness, compliance-practice decoupling, and role ambiguity, are not unique to Wales and align with governance challenges identified in decentralised or voluntary BIM environments (Succar, 2009; Antwi-Afari et al., 2018). International comparators suggest, however, that such constraints can be reduced without legislative mandates if enabling governance infrastructure is established. For example, federal or sectoral initiatives in other contexts have strengthened client-side capability, produced shared guidance, and created cross-sector coordination mechanisms prior to (or instead of) formal mandates (McAuley et al., 2017; Jiang et al., 2022). The Welsh evidence indicates that comparable infrastructure remains limited; the recurrence of the same themes across longitudinal engagement further suggests that time and incremental tool adoption do not automatically produce governance maturity.

This study contributes to BIM governance scholarship in three ways. Theoretically, it provides empirical support for the proposition that governance maturity, rather than the presence of a mandate alone, is a critical determinant of standards-aligned implementation. In doing so, it extends governance-oriented interpretations of BIM maturity frameworks (Succar, 2009) by foregrounding commissioning capacity, accountability structures, and translational infrastructure as core evaluative dimensions alongside technology and process. Practically, the study synthesises a bottom-up governance model grounded in practitioner evidence and triangulated across three data sources. The proposed enabling mechanisms, regional templates, a knowledge hub, automated validation tools, and role-specific training pathways, directly address the mechanisms identified above by (i) strengthening commissioning, (ii) reconnecting documents to workflows through assurance, and (iii) clarifying responsibilities. Methodologically, the study combines longitudinal workshops, semi-structured interviews, and a survey within a single regional context to distinguish between surface-level adoption (tool use and documentation production) and deeper governance capacity (the ability to define, assure, and operationalise information requirements across the lifecycle).

6. CONCLUSION

This study examined BIM and ISO 19650 implementation in the Welsh construction sector, a devolved UK region without a national BIM mandate, centralised funding, or a coordinated implementation framework, drawing on longitudinal workshops (2017–2023), semi-structured interviews, and a national survey. The findings address four research questions and collectively explain why standards-aligned implementation remains uneven in a decentralised setting.

In response to RQ1, the evidence indicates that the dominant barriers are governance-related rather than technological. Stakeholders most consistently reported vague or recycled EIRs, a mismatch between certification and practical competence, documentation treated as a compliance formality rather than a coordination tool, and inconsistent interpretation of ISO 19650 concepts. The survey supports this pattern: while 88% of respondents reported using BIM tools, only 29% reported implementing ISO 19650 or PAS 1192, suggesting that tool adoption has advanced faster than governance readiness for standards-aligned delivery.

Regarding RQ2, four weaknesses in governance structures, documentation, and process alignment were repeatedly

identified. These include the lack of standardised, publicly available templates for EIRs, BEPs, MIDPs, and COBie-related deliverables; the absence of a regional coordination function or knowledge hub; procurement and contractual arrangements that do not reliably define digital roles and accountabilities; and planning documents produced primarily for compliance rather than embedded into everyday workflows, reflecting the compliance–performance decoupling discussed earlier.

For RQ3, the findings show a pronounced asymmetry in how contractors and local authorities interpret and enact their roles in BIM delivery. Contractors, particularly those with stronger digital leadership, often compensated for client-side gaps by revising or drafting EIRs, adapting internal templates, and self-regulating key processes. In contrast, local authorities were frequently described, and also self-reported in the survey, as having limited capacity to specify meaningful information requirements and to evaluate deliverables. This inversion of responsibility shifts interpretive burden to the delivery side and undermines the collaborative governance model assumed by ISO 19650.

Addressing RQ4, stakeholder evidence converged on enabling interventions rather than legislative enforcement. The strategies most consistently supported were the development of regional ISO 19650-aligned templates for core documents, establishment of a Welsh BIM knowledge hub to provide guidance and worked examples, adoption of automated COBie validation and document-compliance checking tools, creation of role-specific training pathways focused on applied competence, and earlier, more structured client engagement to ensure information requirements are meaningful, achievable, and verifiable.

Taken together, the findings support the study's central claim that governance maturity, not mandate presence, is the critical variable for effective ISO 19650 implementation. The Welsh case demonstrates that high levels of BIM tool use can coexist with low standards alignment when enabling infrastructure, templates, guidance, coordination, assurance routines, and accountability mechanisms, remains underdeveloped. The bottom-up governance model articulated here therefore offers transferable implications for other regions seeking to improve BIM governance without centralised enforcement.

Future research should expand the stakeholder base to include designers, consultants, and facilities management teams in order to capture a fuller lifecycle perspective and assess whether the same governance mechanisms persist across appointment, design, delivery, and operations. Comparative multi-region studies would strengthen generalisability, while further work could also develop and evaluate the tools recommended by stakeholders, such as implementation playbooks, automated compliance checkers, and governance-aligned maturity models, to help close the gap between strategic standards and project-level execution.

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