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Standardising Information
Requirements for BIM-Based QA/QC:
A Contractor-Oriented Approach



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European Master in Building Information Modelling

Standardising Information Requirements for BIM-Based OA/OC: A Contractor-Oriented Approach

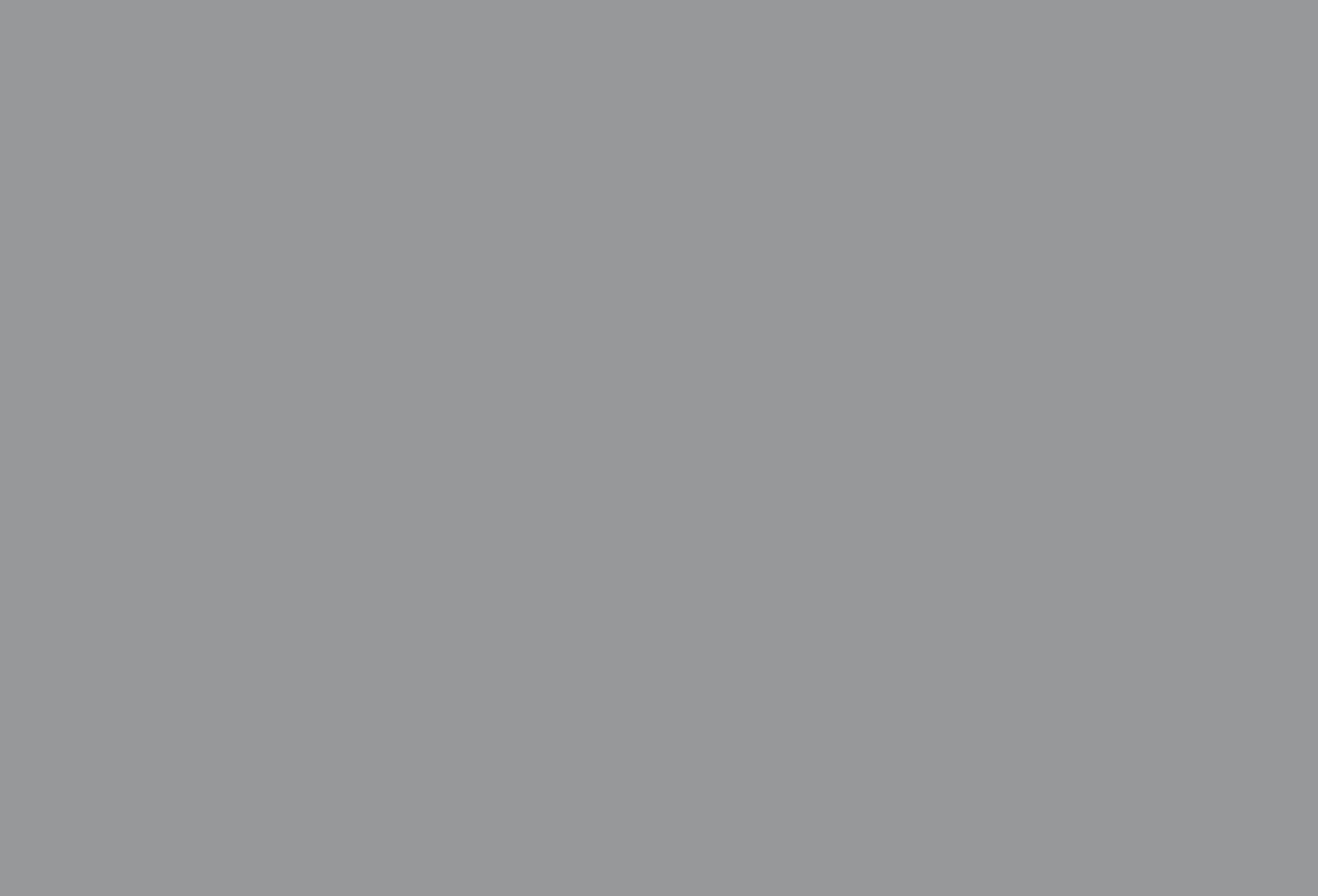
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Universidade do Minho Escola de Engenharia

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Standardising Information Requirements for BIM-Based QA/QC: A Contractor-Oriented Approach

Master Dissertation
European Master in Building Information Modelling

Work conducted under supervision of: **José Carlos Basto Lino**

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

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RESUMO

Padronização dos requisitos de informação para QA/QC em BIM: uma abordagem para empreiteiro

A digitalização da indústria de Arquitetura, Engenharia e Construção (AEC) reforçou a importância das práticas estruturadas de gestão da informação para garantir a garantia e o controlo da qualidade (QA/QC) ao longo do ciclo de vida dos projetos. Dentro da ISO 19650, os Requisitos de Troca de Informação (EIR) e a Especificação de Entrega de Informação (IDS) surgiram como instrumentos-chave: os EIR estabelecem a base contratual para definir as necessidades de informação, enquanto a IDS fornece um que permite a verificação automatizada da conformidade. Juntos, eles complementam-se alinhando a especificação de informações com a verificação, contribuindo diretamente para a confiabilidade, consistência e eficiência dos dados do projeto. Apesar destes avanços, a metodologia para passar da estrutura narrativa dos EIR à lógica formalizada das IDS está ainda subdesenvolvida, limitando o potencial de automatização nos processos de QA/QC.

Esta dissertação aborda esta lacuna através do desenvolvimento de um EIR alinhado com a ISO 19650 e da exploração do caminho de transição das cláusulas EIR para o IDS. Este estudo empregou uma abordagem de métodos mistos, combinando uma revisão da literatura, análise de documentos e colaboração com a BESIX. A validação foi realizada por meio de entrevistas semiestruturadas, pesquisas com gestores BIM e uma aplicação de licitações online, criando uma perspetiva multifacetada sobre usabilidade e adoção. Os dados empíricos confirmaram a robustez do modelo proposto, ao mesmo tempo que destacaram os desafios de legibilidade, adaptação contextual e restrições na fase inicial. Paralelamente, o estudo estruturou cláusulas EIR tipo, mapeou-as em lógica IDS computável e validou a sua aplicabilidade através de casos de teste.

As conclusões demonstram que, embora os requisitos quantitativos e paramétricos possam ser traduzidos com sucesso em IDS para validação automatizada, as cláusulas narrativas, qualitativas e processuais permanecem fora do seu âmbito. O modelo EIR proposto oferece um formato estruturado e preenchível que melhora a usabilidade para os profissionais, mantendo a precisão técnica necessária para fins contratuais e de QA/QC. Além disso, o fluxo de trabalho demonstrado para converter cláusulas EIR selecionadas em IDS confirma a viabilidade de integrar a gestão de requisitos de informação com processos automatizados de verificação de regras.

As contribuições desta dissertação são duplas: (1) o fornecimento de um modelo EIR prático e padronizado que pode ser adaptado pelas organizações para a entrega de projetos e (2) a demonstração de uma ligação metodológica entre EIR e IDS que estabelece as bases para a futura automatização e interoperabilidade na construção digital. Para além da BESIX, estes resultados contribuem para a divulgação mais ampla pela indústria e pela academia, evidenciando como os requisitos de informação estruturados, quando combinados com a validação legível por máquina, podem apoiar processos de QA/QC escaláveis e preparar os empreiteiros para a transição para fluxos de trabalho totalmente digitais.

Palavras chave: Modelação da Informação da Construção (BIM), Requisitos de Troca de Informação (EIR), Especificação de Entrega de Informação (IDS), ISO 19650, Garantia de Qualidade e Controlo de Qualidade (QA/QC)

ABSTRACT

The digitalisation of the Architecture, Engineering, and Construction (AEC) industry has reinforced the importance of structured information management practices to ensure quality assurance and quality control (QA/QC) throughout project lifecycles. Within ISO 19650, the Exchange Information Requirements (EIR) and Information Delivery Specification (IDS) have emerged as key instruments: EIRs establish the contractual basis for defining information needs, while IDS provides a machine-readable format enabling automated compliance checking. Together, they constitute complementary mechanisms aligning information specification with verification, contributing directly to the reliability, consistency, and efficiency of project data. Despite these advances, a methodological bridge between the narrative structure of EIRs and the formalised logic of IDS is underdeveloped, limiting the potential for automation in QA/QC processes.

This dissertation addresses this gap by developing an EIR template aligned with ISO 19650 and exploring the transition pathway from EIR clauses to IDS files. The research employed a mixed-methods approach, combining a literature review, document analysis, and collaboration with BESIX. Validation was conducted through semi-structured interviews, surveys with BIM managers, and a live tender application, creating a multi-layered perspective on usability and adoption. Empirical data confirmed the robustness of the proposed template while highlighting readability challenges, contextual adaptation, and early-stage constraints. In parallel, the study structured sample EIR clauses, mapped them into computable IDS logic, and validated their applicability through test cases in BIM authoring and checking environments.

The findings demonstrate that while quantitative and parametric requirements can be successfully translated into IDS for automated validation, narrative, qualitative, and procedural clauses remain outside its scope. The proposed EIR template offers a structured, fillable format that enhances usability for practitioners while retaining the technical precision required for contractual and QA/QC purposes. Moreover, the demonstrated workflow for converting selected EIR clauses into IDS confirms the feasibility of integrating information requirement management with automated rule-checking processes.

The contributions of this dissertation are twofold: (1) the provision of a practical, standardised EIR template that can be adapted by organisations for project delivery, and (2) the demonstration of a methodological link between EIR and IDS that lays the foundation for future automation and interoperability in digital construction. Beyond BESIX, these outcomes contribute to the broader industry and academic discourse by evidencing how structured information requirements, when coupled with machine-readable validation, can support scalable QA/QC processes and prepare contractors for the transition towards fully digital workflows.

Keywords: Building Information Modelling (BIM), Exchange Information Requirements (EIR), Information Delivery Specification (IDS), ISO 19650, Quality Assurance and Quality Control (QA/QC)

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym Full Form / Meaning

ACC Autodesk Construction Cloud
AIR Asset Information Requirements

AI Artificial Intelligence
AIM Asset Information Model
BEP BIM Execution Plan

BIM Building Information Modelling
bSDD buildingSMART Data Dictionary
CDE Common Data Environment
CIC Construction Industry Council

COBie Construction Operations Building Information Exchange
DEIS Digital Engineering Information Standards (New Zealand)

EIR Exchange Information Requirements

FM Facilities Management
GSL Government Soft Landings

HVAC Heating, Ventilation, and Air Conditioning

IDS Information Delivery Specification

IFC Industry Foundation Classes

IoT Internet of Things

ISO International Organization for Standardization

KPI Key Performance Indicator
LOIN Level of Information Need
LBS Location Breakdown Structure

MEP Mechanical, Electrical, and Plumbing

ML Machine Learning
MVD Model View Definition

NLP Natural Language Processing

OIR Organisational Information Requirements

PIR Project Information Requirements

PLQ Plain Language Question

QA Quality Assurance QC Quality Control

RACI Responsible, Accountable, Consulted, Informed

RIBA Royal Institute of British Architects

SECClasS Sistema de Classificação da Construção (Portuguese Construction

Classification System)

TIDP Task Information Delivery Plan
WBS Work Breakdown Structure

1. INTRODUCTION

The construction industry continues to face mounting pressure to deliver projects that are not only on time and within budget but also meet increasingly high expectations for quality. In this environment, Quality Assurance and Quality Control (QA/QC) systems have evolved into more than site-level compliance mechanisms; they now depend significantly on how well information is defined, structured, and communicated throughout the project lifecycle.

In BIM-enabled project delivery, where digital models drive coordination, planning, and decision-making, the quality of information becomes as critical as the quality of the physical output. At the start of a project, the definition of information needs and expectations is primarily captured through the Exchange Information Requirements (EIR), which act as a contractual foundation for defining what information should be produced, when, by whom, and to what level of detail or quality. However, despite the central role that EIRs are expected to play within the ISO 19650 framework, their implementation remains inconsistent across the industry.

The industry's shift towards data-driven construction has introduced both new opportunities and new responsibilities. On the one hand, digital tools now enable earlier validation of models, better coordination among stakeholders, and improved tracking of deliverables. On the other hand, the effectiveness of these tools depends on the extent to which information requirements are clearly communicated and technically interpretable. Without a well-structured and consistently applied EIR, model-based workflows often suffer from ambiguity, inefficiencies, and costly rework.

Additionally, the global adoption of openBIM standards, such as Industry Foundation Classes (IFC) and Information Delivery Specification (IDS), has introduced new potential for aligning project requirements with automated validation. These standards enable structured, software-independent data exchange and provide a foundation for quality control processes to be performed automatically within digital environments. However, the potential of these technologies is only fully realised when the upstream definition of information, namely within the EIR, is sufficiently structured and detailed to support machine interpretation.

The complexity of large-scale construction projects further amplifies the need for rigorous information management. Projects involving multiple disciplines, geographic locations, and regulatory frameworks demand high levels of coordination and traceability. In such contexts, the initial planning and definition of information requirements serve as the backbone for aligning digital models with contractual obligations and quality expectations. Nevertheless, many organisations continue to approach this task on a case-by-case basis, relying on past experience or outdated templates that may not reflect current project needs or standards.

Challenges such as ambiguity in defining client needs, varying interpretations of information scopes, and the absence of standardised templates have contributed to inefficiencies during project initiation. Furthermore, the lack of formalised mechanisms to translate EIRs into verifiable outputs, such as model-based data checks, has limited the extent to which they support downstream QA/QC processes. This

reveals a critical gap in current digital project delivery: the need for more structured, consistent, and quality-oriented approaches to defining and verifying information from the outset.

1.1. Problem Statement and Motivation

Most large-scale contractors recognise the need for digital information control. However, the lack of precise, verifiable requirements during early project phases continues to limit the reliability of quality control processes throughout the BIM lifecycle.

This dissertation was developed under the roof of the University of Minho in collaboration with BESIX Group, a leading Belgian–Egyptian international construction company headquartered in Brussels. Founded in 1909, BESIX has evolved into a multidisciplinary group operating worldwide. The Group's portfolio spans diverse sectors, including contracting, real estate development, and infrastructure concessions executed through public–private partnerships. BESIX is renowned for its expertise in delivering technically complex and large-scale building projects, marine structures, infrastructure, environmental installations (such as water and waste treatment facilities), and sports and leisure facilities.

Through collaboration with BESIX, it was emphasised that project initiation is often affected by inconsistent approaches to collecting and structuring information from clients. Despite receiving significant volumes of data, teams spend considerable time filtering what is useful, determining what is missing, and reinterpreting expectations. This effort that varies from one project to the next. These inconsistencies not only delay project setup but also introduce risk and ambiguity into the QA/QC processes that depend on timely and verifiable information.

The underlying issue is not the absence of information, but the lack of a standardised and adaptable mechanism for capturing, prioritising, and communicating it at project start. This gap highlights a broader need within the industry for a structured, quality-driven EIR template that strikes a balance between standardisation and project-specific adaptability.

To address this industry-wide gap, the present research focuses on enhancing the strategic role of the EIR within BIM-based quality processes. It examines how a well-structured template can serve not only as a contractual BIM document, but also as a strategic tool for enhancing QA/QC outcomes. By examining real-world practices and gaps in current processes, particularly at BESIX, this research will propose an EIR structure that can help contractors streamline project kick-offs, reduce time waste, and improve overall information quality. Ultimately, this work will aim to reposition the EIR as a proactive driver of quality, rather than merely a compliance document. To further support this vision, the dissertation will also explore the potential of extending EIR specifications into a machine-readable format using IDS. As part of the case study, a selected architectural section of the EIR will be translated into an IDS schema and compared against the IFC export of the model to verify data consistency and conformance. This process is intended to demonstrate how EIR-defined requirements can directly support automated quality validation within BIM workflows, reinforcing the link between structured information planning and robust, technology-enabled QA/QC processes.

1.2. Objectives

The primary goal of this research is to structure and formalise the initial phase of information requirement definition in BIM projects, specifically through a standardised EIR framework, as an essential foundation for enabling effective QA/QC processes. The research positions the EIR not simply as a planning document, but as a key quality-enabling mechanism that ensures clarity, traceability, and reliability of information from the outset of a project.

To achieve this overarching goal, three secondary objectives have been established. The first is to develop structured and adaptable EIR template tailored to the operational context of contractors such as BESIX. This template aims to support consistent project initiation while maintaining sufficient adaptability to accommodate project-specific requirements. The second objective focuses on supporting the automation of QA/QC validation processes by demonstrating how selected sections of the EIR can be translated into machine-readable IDS. This translation enables the implementation of model-checking mechanisms and facilitates the verification of data consistency against IFC exports. The third objective is to ensure that the proposed EIR structure is both contractually applicable and interoperable, enabling its effective deployment across diverse project scenarios, client demands, and software environments.

In response to these objectives, this dissertation aims to develop a solid and comprehensive EIR template that contractors, such as BESIX, can use to standardise their project initiation phase, enabling more consistent and high-quality project outcomes. The proposed EIR template is intended not just as a procedural document but as a quality-enabling tool, helping contractors define, verify, and control information exchanges from the outset, which directly supports and strengthens their QA/QC processes across lifecycle phases. As part of the case study, the research will demonstrate how selected EIR clauses, particularly those related to architectural model content, can be translated into an IDS and validated against an IFC export. This machine-readable approach aims to show how structured information requirements can support automated QA/QC processes, strengthen the link between project planning and execution, and reduce the risk of data misalignment across BIM environments.

1.3. Methodology

This research follows a four-phase methodology to achieve its aim of developing a standardised, quality-oriented EIR template aligned with BIM-based QA/QC workflows and tailored to the operational needs of contractors. In addition to defining the EIR structure, the research includes a focused case study exercise that explores how a small, representative portion of the EIR, specifically related to architectural model content, can be translated into an IDS (Figure 1).

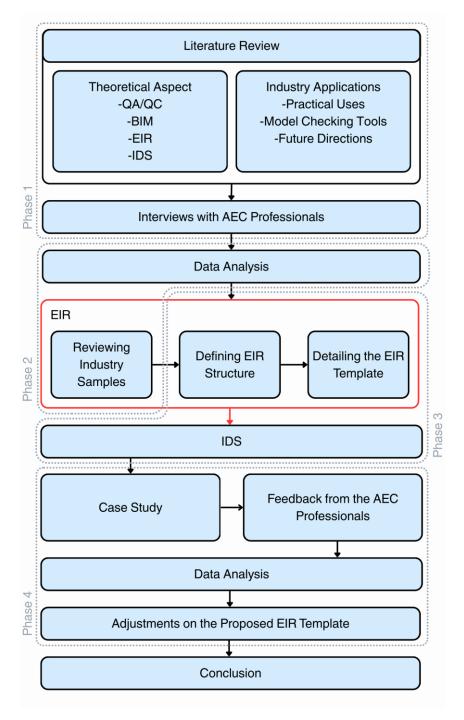


Figure 1 – Research methodology diagram.

Phase 1: Literature Review and Data Collection

The study will begin with a theoretical exploration of key concepts, including QA/QC in construction, the ISO 19650 series, and the role of the EIR in BIM-based information management. This review helped frame the importance of clearly defined information requirements in supporting structured, auditable quality workflows throughout the project lifecycle. In parallel, internal qualitative and quantitative data and insights were gathered through interviews and ongoing communication with BESIX's BIM and QA/QC teams. These exchanges helped clarify how BESIX currently approaches the early stages of project setup and the challenges faced in capturing and managing information received from clients.

Phase 2: Benchmarking and Analysis of Existing EIRs

To identify current best practices and typical content structures, five EIR documents were reviewed from a range of industry sources. They are analysed in-depth, considering their alignment with ISO 19650 principles and relevance to large-scale, multidisciplinary projects. Additionally, internal EIR from BESIX was reviewed to gain insights into how such documents are produced and applied in real-world settings. A comparative analysis of these samples allowed the identification of both essential information blocks (e.g., project goals, model deliverables, information standards) and variable blocks that reflect project- or client-specific needs. This helped establish a core structure for a standardised EIR, while highlighting the need for adaptability to accommodate contextual differences.

Phase 3: Development of the EIR-IDS Pair

Building on the findings from the benchmarking and BESIX interviews, a structured and customizable EIR template has been developed. The goal is to produce a document that can clearly define roles, responsibilities, and deliverables, while aligning with QA/QC protocols and project objectives. As part of a case study, a selected section of this EIR, focused on architectural model deliverables, is translated into an IDS. This translation enables the verification of IFC model outputs against machine-readable information requirements, thereby demonstrating how EIR content can directly support automated quality validation processes in BIM environments.

Phase 4: Validation with BESIX

The final phase of the methodology involves validating the developed EIR–IDS framework with stakeholders at BESIX. Feedback is sought on both the content and structure of the EIR template as well as the usability and technical relevance of the IDS-based case study. This validation ensures that the proposed framework is practical, aligned with BESIX's operational needs, and capable of improving consistency and efficiency in project setup. Recommendations for implementation and potential scalability across other projects and platforms are also developed based on this final feedback stage.

1.4. Dissertation Structure

This dissertation is organised into six main chapters, each contributing to the development, application, and validation of a structured EIR template and its transition into a machine-readable IDS format for improved BIM-based quality assurance and control.

The first chapter of this dissertation introduces the topic by outlining the motivation, objectives, and methodology, while also presenting the dissertation's structure.

Chapter 2 presents a comprehensive literature review that evaluates QA/QC in construction and BIM environments. It discusses the role of structured information management and the importance of EIR and IDS in supporting digital workflows. The chapter concludes by identifying key research gaps and exploring future directions, particularly in relation to artificial intelligence and digital validation workflows.

Chapter 3 presents the development of the proposed EIR template. It begins with the rationale for standardisation and describes the core structure and components of the template. Emphasis is placed on how QA/QC-related requirements are embedded within the EIR and how selected elements can be

translated into machine-readable IDS clauses. The chapter also discusses the standards and tools that support this transition process.

Chapter 4 applies the developed framework to a project scenario. It outlines the application context, demonstrates the practical implementation of the EIR and IDS components, and presents the results of the evaluation. Lessons learned from this process are summarised to inform future improvements.

Chapter 5 captures qualitative feedback from industry professionals through semi-structured interviews and form-based surveys. It analyses stakeholder insights on the applicability, clarity, and relevance of the proposed framework, offering validation from a practical perspective.

The final chapter (Chapter 6) concludes the dissertation by summarising the key developments, discussing implications for industry practice, and proposing future research directions related to structured information delivery and QA/QC integration in BIM workflow.

The dissertation concludes with a list of references and appendices. These last ones contain supporting material such as sample EIR clauses, template components, checklists, and supporting data from the validation phase.

2. LITERATURE REVIEW

Having outlined the structure and objectives of this dissertation, this chapter provides the theoretical and contextual foundation for the research. It begins by examining how QA/QC practices have evolved within the construction industry and explores their integration into BIM-based workflows. The chapter then focuses on the critical role of structured information management in supporting reliable, verifiable, and collaborative project delivery. Particular attention is given to the EIR and Information IDS as mechanisms for formalising information needs and enabling automated quality validation. This literature review not only highlights key developments in the field but also identifies existing challenges and emerging trends that inform the direction and relevance of the proposed research.

2.1. QA/QC in the Construction Industry

Quality Assurance (QA) is defined as the systematic processes within a quality management system that aim to provide confidence that project outcomes will meet specified quality requirements. According to ISO 9000:2015, QA is "part of quality management focused on providing confidence that quality requirements will be fulfilled" (ISO, 2015). In construction, QA includes preventive activities such as process planning, documentation, internal audits, and staff training, all of which are designed to build quality into the project workflow from the outset (Salvi and Kerkar, 2021; Patel and Pitroda, 2021).

Quality Control (QC), by contrast, focuses on fulfilling those quality requirements through operational techniques and checks. It involves the inspection, measurement, and verification of outputs to detect and correct deviations from project specifications (ISO, 2015; Choi et al., 2020). While QA is process-oriented, QC is product-oriented and often conducted at key delivery milestones to ensure compliance before handover.

In the construction sector, the synergy between QA and QC is critical. QA establishes the framework through which quality should be delivered, while QC validates that the deliverables meet the defined requirements. This dual-layered approach contributes to greater reliability, minimises rework, and ensures that contractual obligations are met (Rumane, 2017; Bohrer, 2021). Wawak et al. (2020) emphasise that organisational-level quality factors, such as quality culture, clear responsibilities, and formalised procedures, form a foundational layer that supports consistent quality performance across projects. Their systematic review shows that embedding these factors institutionally can improve the effectiveness and reliability of quality management, particularly in contractor-led construction firms where organisational maturity and standardised QA/QC frameworks are critical for project success.

QA and QC are essential for achieving project goals related to time, cost, and performance. As Rumane (2017) notes, QA/QC processes improve reliability, compliance with client requirements, and reduce rework and costs. Rumane also discusses the interdependence of scope, schedule, and budget in determining project quality. The connection between these three elements has been conceptualised by him as the construction project trilogy (Figure 2), which illustrates how quality is realised when these three elements are simultaneously satisfied. This trilogy is particularly important in construction processes because any imbalance between scope, time, and budget directly undermines QA/QC outcomes, inadequate scope definition leads to rework, unrealistic schedules compromise quality

inspections, and budget constraints can reduce adherence to standards. By framing quality as the result of maintaining equilibrium across these parameters, the trilogy highlights why QA/QC must extend beyond inspection to encompass proactive planning and management throughout the project lifecycle. Traditional QA/QC is heavily reliant on manual inspections and documentation, which poses limitations in scalability, objectivity, and traceability. This has created a growing demand for integrated digital QA/QC systems that are more aligned with modern construction practices.

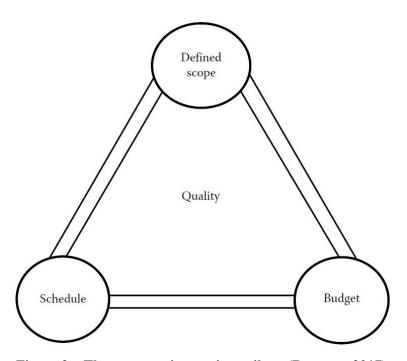


Figure 2 – The construction project trilogy (Rumane, 2017).

The role of QA/QC becomes even more critical when considering industry feedback. For example, Djukic (2023) identifies that despite the availability of checking tools, a lack of integration and alignment with stakeholder requirements continues to hinder effective model collaboration, emphasising that the reliability of a project heavily depends on model integrity.

2.2. QA/QC in BIM Environment

The integration of BIM into construction processes represents one of the most significant digital shifts in the industry's history. While BIM's conceptual roots can be traced back to the 1970s and 1980s, its practical adoption gained momentum in the early 2000s, particularly in Europe, North America, and parts of Asia, as governments and major clients began mandating its use for public infrastructure projects (Eastman et al., 2011). BIM moved beyond its origins as a 3D modelling tool to become a collaborative digital process for managing information across the entire lifecycle of a built asset. As project complexity and data volumes increased, the need for reliable, traceable, and verifiable information intensified, bringing quality management to the forefront of digital construction practice.

This transition has redefined how project information is generated, managed, and validated, starting with the evolution of 3D modelling into the foundation of BIM. The shift from traditional 2D drafting to intelligent 3D modelling began in the 1980s, with early parametric tools such as ArchiCAD and

Vectorworks enabling the representation of building components as data-rich objects (Eastman et al., 2011). By the 1990s, integrated modelling platforms allowed for the combination of geometry and metadata, facilitating design visualisation, documentation, and analysis within a unified environment. As industry maturity increased in the 2000s, BIM evolved into a methodology for multidisciplinary collaboration, linking design intent with scheduling, cost estimation, and facility management (Borkowski, 2023). Within this context, models became not only visual design tools, but structured datasets used to drive decisions, detect clashes, validate compliance, and facilitate ongoing quality assurance and control.

BIM has enabled the centralisation of project data, digital coordination among stakeholders, and the integration of intelligent, rule-based validation tools during both design and construction phases. These developments have redefined the role of QA/QC, shifting them from isolated inspection activities to embedded components of the digital design and delivery process. The shift from general QA/QC frameworks to BIM-specific practices is well illustrated in Bohrer's (2021) model of quality management for BIM projects (Figure 3), which demonstrates how ISO-based quality standards are operationalised into organisational QA systems and further translated into model-level quality assurance activities.

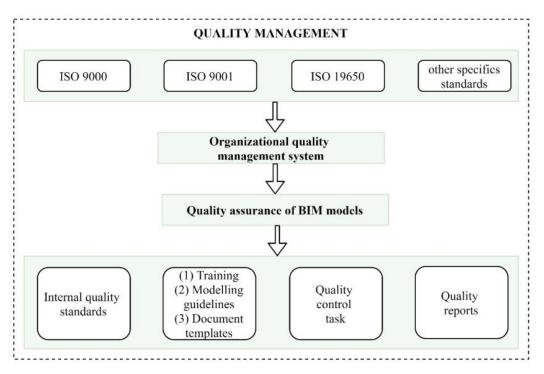


Figure 3 – Quality management of BIM models (Bohrer, 2021).

Building on this visualisation, it becomes clear that the integration of QA/QC into BIM not only requires adherence to standards but also the establishment of systematic practices that differentiate between quality assurance and control activities.

The integration of QA/QC into BIM environments has also redefined their respective roles. Based on a synthesis of standards and academic literature, including, ISO 19650-1 and 19650-2 (2018a; 2018b), Eastman et al. (2009), Kassem et al. (2014), Bohrer (2021), Table 1 compares the roles, characteristics,

tools, and typical examples of Quality Assurance (QA) and Quality Control (QC) practices within BIM environments.

Table 1 – Comparison of QA vs. QC practices in BIM (based on ISO 19650 (2018), Eastman et al. (2009), Kassem et al. (2014), Bohrer (2021))

Aspect	Quality Assurance (QA)	Quality Control (QC)	
Definition	A proactive process focused on preventing defects through structured planning and procedures.	A reactive process aimed at identifying and correcting defects in deliverables.	
Key Characteristics	 Process-oriented Integrated early in the project Emphasises planning, standards, and consistency	- Product-oriented - Performed during or after modelling - Focuses on inspection and conformance	
BIM-Specific Role	Defines information requirements, modelling protocols, LOIN, naming conventions, and model setup rules.	Checks model completeness, property compliance, clash detection, and deliverable accuracy.	
Tools Used	- BIM Execution Plan (BEP) - Exchange Information Requirements (EIR) - Model authoring templates	Information Requirements - BIMCollab/Zhoop - IDS rule checkers	
Examples in BIM	- Embedding modelling rules for geometry and attributes- Defining IFC export protocols- Pre-modelling training	 - Verifying property presence (e.g., fire rating) - Clash detection reports - IFC model validation using IDS 	

Several researchers have demonstrated how rule-based QA/QC logic can be embedded into authoring environments to support real-time compliance and consistency across teams in the digital design and delivery process. Bohrer (2021), for example, emphasises that the quality of a BIM model is directly influenced by the way information is structured during model creation. Her proposed framework integrates QA/QC procedures into authoring tools using logic-based rules that automate compliance verification. These rules produce outcomes such as 'COMPLIANT' or 'NOT COMPLIANT', allowing for early-stage detection of issues and more predictable downstream quality.

Expanding on this logic-driven approach, Bueno and Bosché (2024) translated EN 1090-2 fabrication requirements into graph-based modelling logic, enabling over 4,500 automated quality checks in infrastructure models. Their methodology illustrates how structured rule application can scale across project types and sectors, highlighting the benefits of rule standardisation. Similarly, Barichello Bohrer (2021) outlined a QA process structured into three stages: preparation, rule definition, and rule execution. This model supports greater automation and consistency by embedding computable QA logic at the modelling source.

On the other hand, Eastman et al. (2009) and Solihin and Eastman (2015) demonstrated how design code and client requirements can be integrated into model and content checking processes through the formalisation of rule sets. These practices can be enhanced using software currently common in the

industry, but Bohrer (2021) and others suggest that early-stage checks embedded within the authoring tool are often more effective for ensuring long-term data integrity.

Furthermore, standards like ISO 19650 emphasise the importance of early-stage QA/QC by introducing concepts such as the Level of Information Need (LOIN), EIR, and Common Data Environment (CDE). These principles encourage the explicit definition and verification of information throughout the project lifecycle, forming the foundation for structured model validation. When integrated effectively, they enable contractors to move from isolated quality reviews to a systematic, information-driven approach to quality control.

These standards provide a framework, but practical implementation relies heavily on supporting technologies and applied research. Recent developments illustrate how model-based QA/QC is being operationalised using automation, natural language processing, and AI. One notable contribution is by Peng and Liu (2023), who developed a compliance-checking mechanism that applied natural language processing and knowledge graphs to translate building codes into machine-readable formats. Their approach, demonstrated through case studies, enabled automated verification of regulatory requirements and showed potential to significantly reduce reliance on manual inspection processes.

Further advancements in rule-based validation were discussed by Warren (2019), who identified the increasing use of automated rule-checking tools by architects. However, concerns were raised regarding user confidence, citing insufficient training and tool support as common barriers to effective adoption. An analytical review published in MDPI (2022) reinforced this limitation, highlighting that most BIM QA/QC solutions are implemented reactively, post-design, resulting in inefficiencies related to rework and delay.

A variety of tools and technologies have emerged to support BIM-based QA/QC, ranging from model checkers and rule-based engines to ontology-driven data mapping and AI-powered validation systems. Based on a synthesis of recent academic and industry sources, including works by Eastman et al. (2011), Hjelseth (2016), Kładź and Borkowski (2025), Cerovšek and Omar (2025), Yin et al. (2023), as well as technical documentation on Solibri and Navisworks checking methods, Table 2 presents a categorisation of tools and techniques used in BIM-based QA/QC workflows.

Table 2 – Tools and techniques for BIM-Based QA/QC (Based on Eastman et al. (2011), Hjelseth (2016), Kładź and Borkowski (2025), Cerovšek and Omar (2025), Yin et al. (2023))

Category	Formats/ Technologies	Main Features	Relevance to BIM
			QA/QC
Model Checking	Solibri, Navisworks,	Visual model	Provides visual and rule-
	BIMCollab, BIM Vision	inspection, clash	based feedback to ensure
		detection, geometry and	model completeness and
		property validation	accuracy
Rule-Based	IDS (Information	Automated rule	Enables automatic
Validation	Delivery Specification),	execution based on	validation against
	bSDD, BIMQ	predefined property and	defined project or
		classification	organisational standards
		requirements	
NLP	SPARQL query systems,	Text-to-query	Improves user
Applications	IFC NLP parsers,	conversion, model	accessibility and
	Chatbots for QA	interrogation via	reporting through natural
	documentation	natural language,	communication
		QA/QC report drafting	interfaces
AI Integration	Machine Learning for	Pattern recognition in	Enhances early detection
	anomaly detection,	design errors,	of quality risks and
	Generative AI, Computer	predictive QA metrics,	automates repetitive
	Vision	real-time monitoring	validation tasks
Data Structuring	IFC, IDS, bSDD,	Semantic consistency,	Supports structured data
&	Ontologies	classification mapping,	flow and interoperability
Interoperability	(OWL/SWRL), Model	linking IFC data with	across tools and
	View Definitions (MVD)	external systems	disciplines

Building on these technological capabilities, Bueno and Bosché (2024) proposed a graph-based framework to automatically generate geometric quality checkpoints using 4D BIM data. By digitising European standards, such as EN 13670, their method enabled early planning and scheduling of inspections. Despite the maturity of such technical solutions, their practical application remains limited due to high implementation costs, the absence of standardised procedures, and a lack of trained people.

The increasing reliance on data-rich BIM models across the construction lifecycle has elevated the importance of QA/QC for all project stakeholders. Clients and facility managers depend on the accuracy and completeness of model data to ensure that delivered assets meet operational and maintenance needs. Designers and consultants benefit from early-stage quality validation to reduce design errors and align their outputs with client expectations. Likewise, BIM coordinators and project managers rely on consistent quality standards to coordinate multidisciplinary teams and maintain data integrity across shared environments. In this context, QA/QC is no longer an isolated technical function but a shared responsibility that underpins collaborative delivery and long-term asset value.

Among these stakeholders, large-scale contractors face particularly complex challenges, making structured and repeatable QA/QC processes essential to maintaining performance across diverse projects

and teams. For contractors operating across geographically dispersed and technically complex projects, standardisation and information consistency are critical to maintaining quality across the portfolio. Implementing structured QA/QC practices through BIM not only improves efficiency and repeatability but also reduces risk and enhances decision-making. Bohrer (2021) argues that formalising QA/QC procedures at the organisational level allows teams to benefit from consistent modelling logic and reusable validation rules. Automated self-checks and template-driven quality reviews reduce dependence on individual expertise and make quality processes scalable. Bueno and Bosché (2024) confirm this by showing how graph logic and structured rule templates enable quality planning to be replicated across diverse infrastructure contexts.

Building on these rule-based approaches, recent research has explored the potential of artificial intelligence (AI) and machine learning (ML) to extend quality control capabilities across the construction lifecycle. Datta et al. (2024) describe the use of AI/ML for predictive QA/QC, identifying inconsistencies as early as the planning phase and tracking quality performance through to demolition. They emphasise the importance of structured, semantically rich BIM data in supporting these applications. In a separate domain, Ekanayake et al. (2024) illustrate how deep learning and computer vision are being applied to automate as-built recognition and work-in-progress measurement on construction sites. These innovations enable contractors to complement their rule-based QA/QC procedures with data-driven insights and real-time automation.

The integration of AI into BIM environments is expanding the QA/QC frontier. Rane (2023) highlights how AI applications, including predictive analytics, NLP-based reporting tools, and generative design approaches, are beginning to automate documentation and streamline quality management processes. Building on this, Zheng and Fischer (2023) introduced *BIM-GPT*, a framework that enables natural language dialogue with BIM models, improving accessibility and supporting quality communication. Complementing these efforts, Madireddy et al. (2025) demonstrated how large language models can be applied to compliance checking, translating regulatory requirements into machine-readable formats and generating structured documentation. Together, these developments illustrate how AI, including emerging generative approaches, is pushing QA/QC beyond technical validation into knowledge-based automation.

Underlying all of these innovations is the foundational need for standardised, interoperable BIM models that are both machine-readable and semantically rich. Sacks et al. (2010) reinforce the importance of machine-readable BIM for improving information integrity, while Andreea (2022) highlights openBIM and IFC as critical enablers of interoperability and semantic richness. The structured application of ISO 19650-compliant information requirements (ISO, 2018) further ensures that QA/QC automation can be embedded directly into the information environment. These findings collectively point to a new paradigm in digital construction where QA/QC must be embedded in the information environment itself, rather than simply layered on top of it.

2.3. EIR & IDS and Their Role in BIM

In data-driven construction environments, the quality of information has become as critical as the physical construction work itself. The BIM Handbook emphasises that as BIM adoption matured, defining model uses and deliverables became a persistent challenge, underscoring the importance of

structured requirement frameworks such as EIR (Eastman et al., 2011). To ensure such consistency, two complementary frameworks have emerged as essential tools for enabling robust information delivery and quality control, which are the EIR and the IDS. This section explores the role of both frameworks, their interrelation, and how their integration can support QA/QC in BIM-enabled project delivery.

Within the ISO 19650 framework, information requirements are defined at multiple levels to ensure that project and asset data are structured consistently and support decision-making across the asset lifecycle. At the organisational level, Organisational Information Requirements (OIR) express strategic information needs, while Asset Information Requirements (AIR) specify the data necessary for managing and operating assets. At the project level, Project Information Requirements (PIR) and EIR translate these needs into project- and contract-specific obligations. These requirements feed into the production of the Project Information Model (PIM) and the Asset Information Model (AIM), which constitute the primary information deliverables throughout the project lifecycle. The interrelationships among these elements are illustrated in Figure 4.

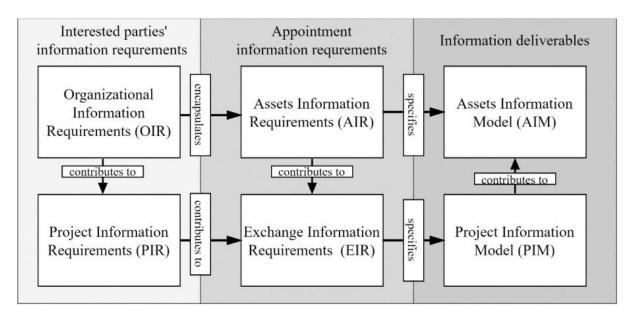


Figure 4 – Hierarchy of information requirements (ISO 19650).

Against this backdrop, the EIR emerges as the most critical contractual instrument for defining, coordinating, and verifying information exchanges between the appointing party and delivery teams. By clarifying *what* information is required, *when* it is needed, *in what format*, and *by whom*, the EIR enables downstream planning, authoring, validation, and acceptance activities to be performed consistently across disciplines. It typically comprises three types of requirements, which are technical (e.g., model formats, naming conventions, classification systems), management (e.g., roles, responsibilities, delivery timelines), and commercial (e.g., contractual conditions tied to deliverables) (ISO, 2018a; UK BIM Framework, 2021).

Beyond documentation, the EIR serves as a strategic mechanism for project setup, helping teams understand expectations and plan accordingly. This strategic role has been highlighted by ISO (2018b), which emphasises that the EIR shapes collaborative BIM processes by specifying clear deliverables and model development protocols. In this way, the EIR functions as a bridge between the client's

information expectations and the appointed party's execution planning. It reinforces the importance of structured LOIN definitions, validation procedures, and file exchange protocols.

Historical perspectives also highlight this importance. Succar (2009) emphasised that structured deliverables and standardised processes form a foundational layer of BIM maturity, aligning with the modern concept of EIR in facilitating better decision-making and digital quality planning. Nevertheless, many projects still fail to fully leverage the EIR's potential as a quality-enabling tool. Studies such as Bohrer (2021) demonstrate that the success of BIM-based QA and QC often hinges on the quality of inputs, namely whether models are developed with clear rules and requirements in mind. In the absence of a well-defined EIR, model checking becomes inconsistent, reactive, and overly reliant on manual review, whereas a well-prepared EIR enables early rule-based checking, improving error detection and reducing costly rework. This perspective is consistent with ISO 19650-2, which recommends that information requirements be structured to support verification and quality checks at defined project stages. Solihin and Eastman (2015) similarly emphasise that validation protocols and rule definitions must be clearly established upfront to enable automated checking.

BuildingSMART International developed IDS to address this need by converting human-readable requirements into machine-interpretable rules. IDS formalises the specific information content required in the information exchange (ISO 29481-1; buildingSMART, 2023) and enables precise validation of object properties, values, and classifications in BIM models. It is structured as XML and is compatible with open standards such as IFC and the buildingSMART Data Dictionary (bSDD).

In the context of QA and QC, IDS serves three complementary purposes. It enables the formalisation of requirements from the EIR, such as object types, property sets, data types, and permissible values, into a standardised structure. It supports verification by allowing exported IFC models to be checked automatically against the IDS to confirm their completeness and conformance. Finally, it ensures traceability by linking requirement clauses with check results, which enhances auditability and facilitates the provision of feedback into authoring environments (buildingSMART, 2020). By performing these roles, IDS bridges the traditional gap between EIR documentation and software-performable validation rules, offering a more precise and consistent approach to data delivery (buildingSMART, 2023). For example, an IDS rule may mandate that doors in a model must include a FireRating property with specified values. When exported alongside the IFC, these requirements can be machine-checked using platforms such as Solibri (Solibri, 2024).

Academic studies further underscore IDS's significance in facilitating automated compliance checking. Tomczak et al. (2024) explored using IDS to validate circularity-related properties in BIM models, demonstrating its utility in semi-automated compliance verification during the sustainability reporting process. Similarly, Bigai and Santos (2024) presented a proof-of-concept showing how IDS can encode Brazilian BIM object standards and effectively bridge requirement-to-IFC mappings. By transforming selected EIR clauses into machine-readable rules, IDS enables automated, repeatable model validation, reducing reliance on subjective manual reviews. This process is well illustrated in the workflow developed by Cerovšek and Omar (2025), shown in Figure 5, which depicts the transition from information requirements to IDS and the subsequent verification of BIM models.

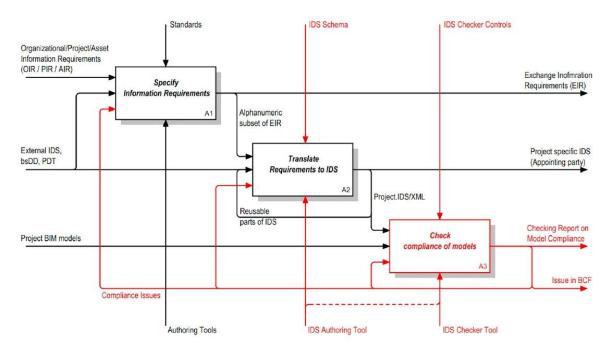


Figure 5 – Generic process for Information Delivery Specification (IDS) use (Cerovšek and Omar, 2025).

For contractors, the integration of structured information planning with digital QA/QC practices is particularly critical given their operations across diverse markets, clients, and software ecosystems. To manage complexity at scale, project teams require standardised templates that are both technically enforceable and adaptable to project-specific conditions. In this context, an EIR framework that is not only well-structured but also extendable into machine-readable formats, such as the IDS, becomes essential. By translating selected EIR clauses into IDS, contractors can enable automated, software-performable validation of IFC model content, reducing ambiguity and improving the traceability of information exchanges. This capability enhances coordination between stakeholders, supports early detection of data inconsistencies, and builds greater trust in BIM deliverables by embedding quality checks directly into the digital workflow.

Despite its potential, the consistent implementation of EIR-driven, IDS-enabled workflows remains challenging. Studies have reported variability in how EIRs define data drops, CDE protocols, and responsibility matrices, which leads to inconsistencies in downstream data delivery (Zima & Mitera-Kiełbasa, 2021). Efforts to extend IDS, such as incorporating XLink-based references or tight integration with the bSDD, have improved semantic clarity but also exposed gaps in cross-tool interoperability and exception handling (Kremer & Beetz, 2023; Cerovšek & Omar, 2025). Case evidence indicates that aligning ISO 19650 principles with openBIM standards enhances traceability, yet stakeholder misalignment and software constraints can still limit effectiveness (Yousfi et al., 2024). These findings suggest that while ISO 19650 provides a coherent framework, additional operational support and tool maturity are required to achieve end-to-end, automated verification in practice.

In light of these challenges, it is important to recognise the underlying conditions under which EIR and IDS can effectively support digital QA/QC, thereby turning theoretical potential into practical implementation. This EIR to IDS linkage provides the conceptual and technical foundation for the case

study presented in later chapters, where selected EIR clauses are translated into IDS and applied to IFC exports to demonstrate machine-readable conformance checking. In doing so, the EIR is repositioned from a static planning document to a quality-enabling instrument embedded within BIM-based delivery.

2.4. EIR to IDS Workflow

The transformation of EIR into IDS represents a critical step in formalising BIM-based data exchanges. While the conceptual role of each has been discussed in the previous section, their practical implementation often reveals gaps between intended requirements and verifiable outputs.

This contrast is illustrated in Figure 6, which compares traditional EIR-driven workflows with IDS-supported practices. In traditional approaches, requirements are documented in human-readable form and later reinterpreted by modelling teams, often leading to inconsistent validation and late detection of errors. IDS-supported practice, on the other hand, enables requirements to be expressed in machine-readable form, allowing models to be validated automatically and providing real-time feedback during the design and delivery process.

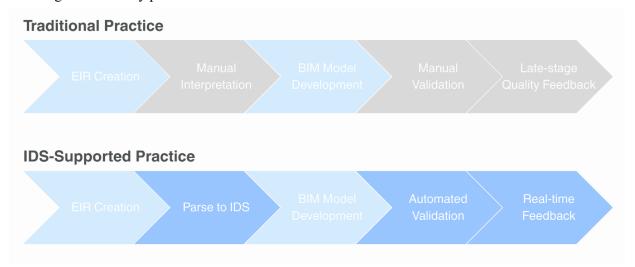


Figure 6 – Comparison of traditional EIR-based practice and IDS-supported practice in BIM workflows.

By visualising the shift from interpretation-heavy processes to automated validation, this diagram sets the foundation for examining the current state of practice. Although the theoretical pathway from EIR to IDS is clear, its consistent implementation in projects remains challenging.

Although the transformation from EIR to IDS is theoretically well defined, its implementation in practice is rarely seamless. The discrepancies between what the literature envisions and what is observed in practice are evident across several aspects of EIR and IDS implementation. Zima and Mitera-Kiełbasa (2021) highlighted that many EIRs lacked precise definitions of data drops, CDE protocols, and responsibility matrices, which limited their effectiveness despite ISO 19650 guidance. More advanced expectations, such as machine-readable requirements through IDS, have been explored in research extending IDS semantics and service integration (Kremer and Beetz, 2023) and in ontology-based frameworks that evaluated tool interoperability (Cerovšek and Omar, 2025). At the same time, pilot studies have demonstrated the potential of IDS for semi-automated compliance checking, for instance,

in sustainability-related use cases (Tomczak et al., 2024). These findings collectively illustrate a consistent pattern: literature promotes structured, standardised, and automated approaches, yet practice frequently lags due to limited adoption, tool immaturity, and insufficient training. This contrast is synthesised in Figure 7.

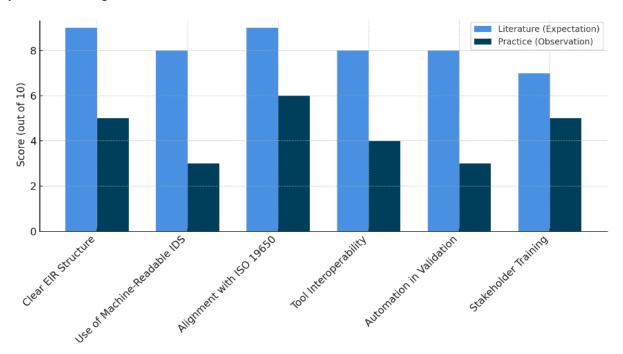


Figure 7 – Synthesis of gaps between literature expectations and practical implementation of EIR and IDS (Based on Zima and Mitera-Kielbasa (2021), Kremer and Beetz (2023), Cerovšek and Omar (2025), and Tomczak et al. (2024)).

Advancements in IDS frameworks have attempted to address these inconsistencies. Kremer and Beetz (2023) extended existing IDS structures by incorporating XLink functionality, allowing for geometric and semantic validation within IFC-based environments. Their research underscored the potential of linking model checking with the bSDD to enrich verification processes. Similarly, a recent study presented at the 2024 ICCC conference mapped IDS clauses to IFC entities and evaluated their compliance using automated tools. However, notable challenges were reported in terms of tool interoperability and the lack of end-to-end automation. These limitations are consistent with the findings of Cerovšek and Omar (2025), who analysed three IDS workflows (internal, external and hybrid) and identified weaknesses in exception handling, tool maturity, and reporting consistency.

A practical case study by Yousfi et al. (2024) investigated the integration of ISO 19650 principles with openBIM standards during a complex renovation project. The study showed that this combination supported more structured information management and improved traceability across project data exchanges. However, the researchers also observed persistent challenges, including misalignment of stakeholder expectations and software interoperability limitations, which constrained the overall effectiveness of the approach. These findings highlight that, while ISO 19650 provides a coherent framework for structured information delivery, additional operational support and tool maturity are needed to achieve consistent implementation and verification in practice.

On the other hand, efforts to enhance interoperability within the construction and facility management sectors have increasingly focused on linking BIM environments to adjacent systems such as Geographic Information Systems (GIS), Internet of Things (IoT) platforms, and asset management databases. Quinn et al. (2020) demonstrated how IoT data streams from building automation systems could be integrated with FM-BIM models through a cloud-based architecture, enabling near-real-time performance monitoring and providing a foundation for digital twin applications to support lifecycle-based decision-making.

Semantic web approaches have also been investigated to support interoperability. Ontology-based systems, such as those developed using OWL and SWRL, have enabled automated rule execution by embedding logic into BIM models. These frameworks allow for richer semantic querying and reasoning, facilitating connections between disparate domains. Nevertheless, standardisation remains an unresolved issue. Zhang's ontology-driven framework, while promising, highlighted difficulties in aligning domain-specific ontologies with existing industry schemas.

It has been observed that current interoperability solutions often rely on middleware or model view definitions (MVDs), which require extensive manual configuration. This reliance hinders scalability and limits the use of real-time applications. Despite notable achievements in semantic integration, a universally adopted, streamlined interoperability protocol for QA/QC and BIM-based data delivery has yet to be realised.

2.5. Identified Gaps and Future Directions

The shift toward digital construction has prompted numerous proposals for enhancing QA/QC practices in BIM environments. As BIM adoption increases, particularly among large contractors, aligning quality management with data-driven workflows has become a pressing objective. Several future-oriented strategies have emerged from the literature to support this transformation.

One of the most critical advancements involves the early integration of quality planning into BIM execution strategies, as emphasised by Bohrer (2021) and aligned with the principles outlined in ISO 19650. Additionally, the implementation of embedded rule-based systems and reusable templates is recommended to automate compliance checks and reduce manual validation efforts (Bohrer, 2021; Bueno & Bosché, 2024). Ensuring cross-software interoperability through the adoption of openBIM standards has been highlighted as a fundamental requirement for seamless collaboration (Andreea, 2022), while Sacks et al. (2010) emphasise BIM's role in fostering integration and information sharing across disciplines, a perspective also reflected in the BIM Handbook (Eastman et al., 2011).

In parallel, advanced technologies such as machine learning, semantic reasoning, and generative AI are being explored to support anomaly detection, predictive QA/QC, and natural language model interaction (Mostafa et al., 2023; Datta et al., 2024; Rane et al., 2023). To illustrate, Esmaeili et al. (2024) applied machine learning algorithms to detect inconsistencies in structural elements, such as openings in precast concrete walls, within BIM models. Their model demonstrated high accuracy in anomaly detection, indicating the potential for predictive quality control before physical construction begins. NLP-driven tools, such as those developed by Yin et al. (2023), which is an ontology-based parser that translates user-defined questions into SPARQL queries, enabling IFC model interrogation with a reported

accuracy of 91%, have shown promise in improving model accessibility through query systems. Exploratory studies also point to blockchain's potential to establish audit trails and ensure delivery conformance, although its practical integration remains limited.

These advancements mark that QA/QC has transitioned from manual inspections to a digitally enabled, integrated practice, essential for managing quality in modern, BIM-based construction environments, particularly for contractors seeking efficiency, accuracy, and consistency across their operations. However, despite their promise, challenges remain in translating innovation into consistent and scalable practice. Organisational and technological barriers often constrain implementation, particularly in contractor-led projects with varying scopes, teams, and delivery conditions. These challenges echo issues already noted in early BIM adoption literature, where unclear model deliverables and fragmented processes limited effective quality assurance (Eastman et al., 2011).

Another important aspect concerns the institutionalisation of QA/QC procedures at the organisational level, which promotes consistency across multiple projects and aligns internal processes with external standards (Bohrer, 2021; Zhang et al., 2018). Finally, the integration of AI technologies, including predictive analytics, NLP-based tools, and generative design approaches, has been proposed as a means to improve knowledge management, support training efforts, and streamline QA documentation practices (Rane, 2023).

Based on this review, several key research gaps have been identified that continue to limit the effectiveness and scalability of BIM-based quality management in construction projects. First, there remains a lack of standardised EIR templates specifically tailored to the needs of contractors, templates that can provide structured, quality-focused requirements while still allowing for project-specific adaptability. Second, few practical methods have been proposed for translating EIR content into machine-readable IDS, particularly in relation to model elements relevant to QA/QC. A third gap concerns the limited integration of rule-based quality validation processes directly into early-stage design workflows. Although many tools support checking at later stages, contractors still lack embedded QA/QC mechanisms within commonly used authoring environments. In addition, tool interoperability remains fragmented. Current digital solutions rarely support seamless transitions across EIR definitions, IDS mapping, IFC model content, and automated verification systems. Finally, the alignment between contractually binding information requirements and digital model-based QA outputs remains underexplored, leaving a disconnect between formal documentation and operational validation processes.

These literature-identified gaps were further validated through a site visit to BESIX headquarters in May 2025. Five focused sessions were conducted with professionals across roles, including BIM managers, BIM coordinators, and software developers. The discussions revealed recurring challenges that directly mirrored the gaps highlighted in the literature.

The Head of the BIM Team noted that while many of the company's processes were implicitly aligned with ISO 19650 principles, these links were not systematically recognised, limiting their institutional value. He highlighted the dual role of QA/QC as both a quality and risk management function, while also emphasising the recurring challenge of incomplete or unclear EIRs provided by clients. The absence

of a structured framework was seen as more critical than additional automation, with clarity on the intended user audience (site managers, project managers, or operations staff) regarded as essential for effective implementation.

A software developer demonstrated a prototype tool created in response to a BIM manager's request, which linked Revit model exports with Power BI dashboards to provide compliance statistics. While the tool successfully visualised alignment between model data and project-specific requirements, the absence of a standardised reference for which parameters should be checked meant that every project required manual setup, reinforcing the value of reusable, standardised templates and EIR-to-IDS workflows.

Discussions with a BIM Manager revealed challenges at project initiation, where design packages received from clients often contained fragmented, incomplete, or irrelevant information. Without early-stage QA/QC, these deficiencies propagated into later phases, creating inefficiencies and miscommunication. This underscored the need for systematic data validation and filtering before execution begins.

Further insights were provided by a BIM Coordinator working on a tunnel project, who described project-specific QA/QC procedures designed from scratch for that case. The process relied on critical parameter checks and clash detection, but subcontractors struggled to interpret and populate parameter requirements consistently. The lack of a unified approach across projects required repeated clarification, adding delays and resource burdens.

Another BIM Coordinator demonstrated a site-based QA/QC workflow piloted entirely within ACC using iPads. While this approach centralised validation activities and produced clear quality metrics, it faced resistance from site teams unaccustomed to digital workflows. The experience highlighted the importance of user experience and change management in implementing QA/QC innovation.

Taken together, these sessions revealed gaps in standardisation, communication, and early-stage data validation, while also showcasing innovative practices emerging organically within the company. The observations confirmed that the identified gaps are not merely theoretical but constitute real challenges faced by contractors in daily practice.

These gaps underscore the need for more structured, verifiable, and interoperable workflows that can support the digital transformation of quality management. This dissertation specifically addresses the first two gaps by developing a contractor-oriented EIR template and demonstrating a method for translating selected EIR content into IDS to support the QA/QC process.

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3. EIR TEMPLATE

3.1. Rationale

The challenges and research gaps outlined above highlight a growing need for more standardised, project-relevant, and verifiable approaches to defining information requirements in BIM-based construction. In particular, the absence of adaptable EIR templates aligned with QA/QC objectives has been identified as a critical barrier for contractors seeking to implement structured, model-driven quality management workflows. In response to these needs, the following chapter presents the development of a structured EIR template tailored to the context of contractor-led project delivery. The template aims to address information ambiguity, support automation through IDS translation, and improve alignment with ISO 19650-based information management practices.

The need for a structured and standardised EIR template arises from recurring inefficiencies and inconsistencies observed in current industry practices. In many projects, EIRs are either too generic or overly detailed without alignment to project goals or QA/QC processes. Such variability often results in misinterpretation, lack of compliance, and additional time spent clarifying expectations among stakeholders (Zima & Mitera-Kiełbasa, 2021). During initial project phases, contractors face challenges in clarifying expectations from the subcontractors, distinguishing between essential and redundant data, and establishing a unified understanding of deliverables. This lack of clarity can propagate into later project stages, undermining quality control and data validation efforts (Bohrer, 2021).

A structured EIR template addresses these challenges by providing a repeatable framework for defining project-specific requirements while ensuring consistency across disciplines. By standardising information blocks such as project objectives, modelling scope, deliverable formats, naming conventions, and verification protocols, the EIR becomes a foundational instrument for aligning stakeholders and enabling traceable, high-quality information delivery throughout the asset lifecycle (ISO, 2018a; Succar, 2009).

The structured EIR also plays a key role in reducing project-specific interpretation by external consultants and subcontractors. In many cases, the absence of a unified template leads to varied interpretations of the same requirements, depending on who is reading them. This variability can compromise data accuracy and lead to coordination issues during design reviews, clash detection, and later construction activities. By establishing a shared vocabulary and expected data outputs, the structured EIR enhances consistency in model authoring and review. (CIC (2013); Eadie et al. (2013); Miettinen & Paavola (2014)).

Moreover, the template facilitates better alignment with ISO 19650-compliant workflows and serves as a foundation for developing other essential information management documents, such as the BIM Execution Plan (BEP) and Task Information Delivery Plans (TIDPs). When the EIR is systematically organised and clearly written, these downstream documents become easier to produce and maintain, ensuring that the project's information flow remains coherent and auditable (UK BIM Alliance, 2021).

Finally, by promoting reusability, a structured EIR template supports knowledge transfer and process maturity within organisations. Lessons learnt from previous projects can be incorporated into future EIRs more efficiently, allowing organisations to gradually improve their internal standards and reduce redundant setup efforts at each project's start. This not only streamlines mobilisation but also supports continuous improvement in BIM-based quality management (Succar, 2009).

3.2. Structure and Components

In the development of the proposed EIR template for BESIX, a total of eight exemplary EIR documents were reviewed to evaluate their structure, alignment with ISO 19650, and suitability for informing a standardised and practical template. Among these, five were selected as the most relevant and impactful for detailed reference and adaptation.

Foremost among them is the buildingSMART Portugal EIR Template (buildingSMART Portugal, 2024), which carries significant weight within the BIM community due to its origin under the buildingSMART brand, a global leader in openBIM standards. This template is tailored to the Portuguese technical and regulatory context and aligns closely with ISO 19650-2:2018. It offers a technically rigorous structure for defining Organisational and Project Information Requirements (OIR/PIR), LOIN, file naming conventions, acceptance criteria, and asset data strategies. Its integration with the national SECClasS classification system and emphasis on open data make it particularly relevant for enabling standardised, interoperable information exchange.

The second reference is the CIC BIM EIR Template (Construction Industry Council, 2021), developed in Hong Kong to support widespread BIM adoption. It provides a modular, ISO-compliant framework with predefined BIM uses, deliverables, roles, and collaborative workflows, aimed especially at supporting SME adoption. Third, the KiwiRail Digital Engineering EIR (KiwiRail, 2024) exemplifies infrastructure-specific digital engineering practices, combining rich technical specifications with lifecycle asset management. It incorporates model attribution protocols, clash detection, GIS, and CDE processes and is underpinned by New Zealand's Digital Engineering Information Standards (DEIS). Fourth, the New Zealand BIM Handbook – Appendix F (Building Innovation Partnership, 2023) serves as a nationally endorsed EIR template with practical deliverables, a detailed RACI matrix, and model validation requirements that support structured delivery from early design through handover.

Finally, the UCL Estates EIR (University College London, 2022) represents a live, institutional implementation of BIM Level 2 methodologies within a public-sector environment. It integrates Government Soft Landings (GSL), COBie handover requirements, KPI frameworks, and long-term data delivery for operational use. The inclusion of detailed response expectations in BEPs and asset-related deliverables makes it especially applicable for client-driven digital information management.

The three remaining EIR templates reviewed, namely the UK BIM Framework Core Content and Guidance (CDBB, 2017), the BIM Toolkit EIR Guidance (NBS, n.d.), and a private-sector draft, were informative for foundational understanding but were excluded from detailed reference due to limitations in scope or currency. The selected five documents collectively provide a robust basis for establishing ISO 19650-compliant, lifecycle-oriented EIR documentation that supports both contractor-side

workflows and client-side expectations. To consolidate the findings of the review, the five selected reference EIR templates are summarised in Table 3, highlighting their origin, context, and main features.

Table 3 – Overview of selected reference EIR templates

Reference EIR Template	Year	Context / Origin	Main Features
buildingSMART Portugal EIR Template	2024	Portugal, buildingSMART Portugal	-ISO 19650-2 aligned -SECClasS integration -LOIN and file naming -Asset data strategies -Open data focus
CIC BIM EIR Template (Hong Kong)	2021	Hong Kong, Construction Industry Council	-ISO-compliant -Modular framework -Predefined BIM uses -SME adoption support
KiwiRail Digital Engineering EIR	ail Digital Engineering EIR 2024 New Zealand, KiwiRail		-Infrastructure-specific -Lifecycle asset management -CDE and GIS integration
New Zealand BIM Handbook – Appendix F	2023	New Zealand, Building Innovation Partnership	-Nationally endorsed -RACI matrix -Validation requirements -Structured delivery
UCL Estates EIR	2022	United Kingdom, University College London	-Public-sector focus -GSL and COBie -KPIs -BEP response requirements

Using these five exemplars as functional inputs, the BESIX template was structured around the eight recurring chapter categories identified during the review phase. This structure was then calibrated to reflect internal documentation and practices specific to BESIX, including proprietary software preferences, model coordination protocols, and company-specific terminology. Strategic integration with downstream deliverables, particularly the BIM Execution Plan (BEP), was also a priority, ensuring that all information requirements could be operationalized by delivery teams without ambiguity. Where appropriate, clauses were expanded to address the company's quality assurance standards, preferred CDE workflows, and role accountability models.

Ultimately, the development process balanced the need for international best practice with internal alignment, resulting in a fit-for-purpose EIR template that can serve as a replicable standard across BESIX's project ecosystem while remaining flexible for project-specific customisation.

To achieve this, the template was organised around the three core requirement types defined in ISO 19650 as technical, management, and commercial, and an additional section called 'Training/Capability' reflecting insights from the reviewed industry samples. (Figure 8) Each of these requirement types is further subdivided into modular information blocks to enhance readability and adaptability. The modular organisation is illustrated in Figure 8, which highlights the core categories and their respective subcomponents.

Proposed EIR Template Technical Exchange & Asset Information Requirements (OIR, PIR, AIR) Level of Information Need (LOIN) Data Structures, Formats & Naming Information Security & Assurance Management Roles, Responsibilities & Approval Protocol Coordination Procedures & Review Cycles Common Data Environment & Metadata BEP Alignment and Information States Commercial Tendering and Procurement Information Validation and Sign-off Requirements Model & Data Delivery Conditions Legal & Contractual Clauses (if applicable) **Training/Capability** Training Plans and Onboarding Role-Specific Competency Requirements Evidence of Qualifications Project-wide BIM Skill Assurance

Figure 8 – Modular structure of the proposed EIR template.

The technical section includes specifications for modelling practices (e.g., LOIN, classification systems, software formats), naming conventions, file structures, and expected outputs. The management section outlines roles and responsibilities, information delivery schedules, data drop timelines, and coordination protocols. The commercial section addresses terms and conditions related to information provision, including acceptance criteria and change control procedures.

Building on this conceptual grouping, the categories were arranged into a sequential document structure tailored for BESIX. This structure translates the modular blocks into practical chapters, ensuring that requirements are presented in a logical order consistent with both ISO 19650 and internal company practices. The alignment between the conceptual blocks and the document chapters is shown in Figure 9.



Figure 9 – Proposed EIR template structure, colour-coded by requirement type.

A key feature of the template is its adaptability, where certain sections contain predefined fields with dropdown options or structured guidance, while others allow free-text input for context-specific details. This balance supports both standardisation and project-specific tailoring, making the template suitable for use across diverse contracts and regions.

To further support clarity and adaptability, the template also integrates a metadata header in each section that captures project-specific identifiers such as project name, contract ID, client name, and document versioning. This aids in managing multiple projects simultaneously and ensures that the most current version of the EIR is traceable throughout its lifecycle. Version control and document history tracking are especially important when updates must be communicated across multidisciplinary teams.

Additionally, the EIR template includes references to standard classifications and data schemas such as the Uniclass systems, as well as IFC-based property sets. These references serve to harmonise terminology and modelling conventions, supporting both interoperability and downstream use of structured data in validation processes and facilities management.

The modularity of the template allows different teams, architects, structural engineers, and contractors to contribute to or extract relevant sections as needed. For example, modelling-specific LOIN requirements for architectural models can be elaborated in dedicated sub-sections without cluttering other parts of the document. This discipline-based organisation fosters better engagement and reduces misalignment between authoring and reviewing parties.

Furthermore, the inclusion of visual guidance, such as data templates or sample model views, is planned as part of the implementation guidance accompanying the EIR. These resources will provide users with practical illustrations of modelling expectations, aiding less experienced contributors and enhancing the document's usability across diverse teams and geographic regions.

3.3. Embedding QA/QC Information Requirements

To ensure that the EIR supports robust QA/QC processes, quality-oriented information requirements have been explicitly embedded within the template. These include clear criteria for model validation, model checking responsibilities, data accuracy thresholds, and compliance protocols with reference standards.

Each modelling discipline section includes a quality specification block, where expected property sets, attribute completeness, and geometric consistency checks are outlined. These quality requirements are designed to be verifiable, either manually or via automated tools, supporting downstream validation workflows. Furthermore, the EIR includes provisions for documenting QA/QC responsibilities across parties, referencing model validation reports, and detailing non-conformance handling procedures.

By integrating these elements, the EIR transitions from a planning document to an actionable QA/QC tool, fostering traceability and reducing ambiguity in quality expectations from the outset.

In addition to discipline-specific validation criteria, the EIR also outlines requirements for data provenance and auditability. This includes specifications on who must author, review, and approve model content at each delivery stage, as well as mandatory documentation of version histories and revision logs. These provisions support the integrity and traceability of information exchanges, which are essential to effective QA/QC oversight.

The EIR template also encourages the integration of pre-checklists or quality gates before information is submitted into the CDE. These quality gates ensure that each file or model meets minimum QA requirements before progressing into shared or published status. By formalising these interim checks, the EIR helps minimise downstream errors and reinforces a culture of proactive quality management.

Finally, references to external quality standards, such as ISO 9001 or national BIM QA protocols, can be embedded directly into relevant sections of the EIR to ensure alignment with broader organisational

quality systems. This enhances consistency across projects and strengthens the linkage between digital information management and corporate QA/QC frameworks.

3.4. EIR to IDS Transition

The process of transitioning from human-readable EIR clauses to machine-readable IDS involves the identification, extraction, and formalisation of structured requirements that can be validated against IFC models. The methodology adopted in this research consists of four key steps as illustrated in Figure 10.

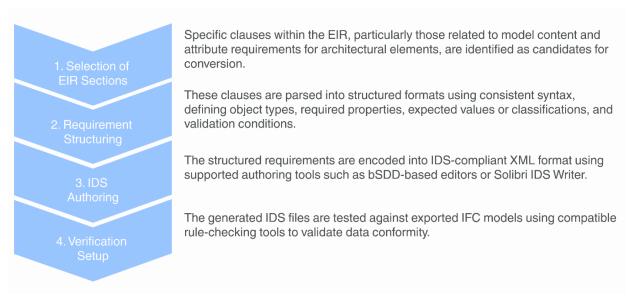


Figure 10 – EIR to IDS methodology adopted.

This case study methodology demonstrates how EIR content can be transformed into actionable validation logic, laying the groundwork for scalable, automated quality assurance.

While the initial implementation focuses on a limited set of architectural objects, the methodology is designed to be scalable across disciplines. For instance, future extensions may include structural or MEP components, where specific property sets and classification codes are equally critical for validation. By establishing a repeatable approach to mapping requirements to IDS syntax, the methodology supports wider adoption across various modelling domains.

To ensure semantic consistency during the structuring and authoring phases, alignment with the bSDD is integrated into the workflow. Leveraging bSDD helps reduce ambiguity by referencing shared definitions and international classification systems. This not only enhances interoperability but also simplifies the integration of IDS content into rule-based checking environments.

To illustrate the practical application of this methodology, a specific clause from the architectural section of the EIR was selected for conversion. The clause stated, "All door objects must contain the following attributes: FireRating, AcousticRating, OperationType, and Material, and must be classified using Uniclass 2015." Following the steps outlined above, this requirement was structured and encoded into IDS (Figure 11).

Figure 11 – Example IDS fragment for IFC door entities.

This IDS fragment was authored using Solibri IDS Writer, with entity names and property definitions aligned with bSDD to maintain semantic accuracy. During validation, the IDS file was tested against an exported IFC model, and the checking tool flagged several instances where attributes were missing. This outcome initiated a feedback loop with the modelling team, leading to improvements in both modelling practices and requirement interpretation.

However, despite the strengths of this approach, it is essential to acknowledge the limitations of IDS in its current form. Not all types of EIR clauses can be directly translated into machine-readable logic. For instance, narrative or qualitative instructions, such as "models must be easy to understand" or "suitable for stakeholder presentations", lack the formal structure needed for encoding. Similarly, procedural directives like "upload model files every Friday to the CDE" fall outside the scope of IDS, which focuses solely on validating data content within BIM models. Additionally, IDS currently does not support complex logical conditions across object types, such as "clash checks only between structural columns and ventilation ducts." (buildingSMART, 2022; Cerovšek and Omar, 2025).

The extent to which different types of EIR clauses can be translated into IDS requirements is summarised in Table 4, highlighting which clauses can be formalised as machine-readable rules and which remain dependent on procedural or human interpretation.

EIR Clause Type	Translatable to IDS?	Notes
Property presence (e.g., FireRating)	Yes	Mapped to object-property pairs
Classification requirements	Yes	Can reference Uniclass, Omniclass, etc.
Procedural instructions (e.g., upload weekly)	No	Handled via BEP or CDE protocols
Narrative goals (e.g., "easy to read")	No	Requires human review
Conditional logic across objects	Partial	Currently limited by the IDS schema

Table 4 – Translating EIR clause types into IDS requirements

These limitations indicate that while IDS can automate a significant portion of model compliance checking, it cannot yet replace the full scope of QA/QC review. As such, it should be applied in parallel with human oversight and procedural checks defined in documents like the BEP or project protocols. The methodology proposed here incorporates a feedback loop that not only improves the clarity of encoded requirements but also supports continuous refinement of authoring practices, enhancing future transitions from EIR to IDS.

Finally, documentation and version control procedures are embedded into the methodology to track changes in both EIR clauses and their corresponding IDS translations. This ensures transparency in the evolution of project requirements and provides a clear audit trail for QA/QC teams, ultimately strengthening accountability and traceability throughout the digital delivery process.

3.5. Tools and Standards for the Transition

The transition from EIR to IDS relies on a combination of standards and tools that enable information to be structured and machine-readable. While the previous section outlined the conceptual roadmap for this transition, it is equally important to review the standards and digital solutions that operationalise the process in practice.

At the foundation of this ecosystem lies the ISO 19650 series, which defines principles for managing information across the lifecycle of built assets. Within this framework, the EIR formalises the requirements for information to be delivered, specifying what is needed, in which format, and at what point in the project (ISO, 2018; UK BIM Framework, 2021). Complementing this framework is the concept of LOIN, introduced in ISO 19650-1 and detailed in ISO 19650-4 and ISO 12006-3. LOIN provides a structured way to define the granularity of information in terms of quality, quantity and detail, replacing the less precise concept of Level of Development (ISO, 2022; ISO, 2020; Kremer & Beetz, 2023).

Alongside these management-oriented standards, IFC (ISO 16739) establishes the open and neutral schema for BIM data, providing the reference structure against which IDS requirements are validated (ISO, 2018b). BuildingSMART developed the IDS schema as an XML-based standard that enables requirements to be expressed in a machine-interpretable format, ensuring they can be automatically validated against IFC model data (buildingSMART International, 2024a; buildingSMART International, 2024b).

On the other hand, classification systems such as Uniclass, OmniClass, or MasterFormat provide consistent categorisation of building elements and activities, allowing their integration into IDS for improved standardisation and cross-project comparability (ISO, 2015; Chung, Choi et al., 2020).

The integration of standards such as IFC, IDS, and classification systems provides the theoretical foundation, but it is through dedicated tools that these requirements are translated into project workflows. The tools available to support IDS authoring and validation vary considerably in complexity and usability. The earliest method is manual XML editing, which provides flexibility but requires detailed knowledge of the schema and IFC structure and is prone to human error. To address these limitations, prototype editors and validators developed by buildingSMART have been introduced,

providing environments for schema-compliant IDS creation and validation. These tools ensure strict adherence to the standard but demand advanced technical knowledge and are less suitable for everyday project use (buildingSMART International, 2024a).

Recent developments have focused on improving usability through commercial and platform-integrated editors, such as usBIM IDS and similar tools. These provide graphical interfaces with drop-down selections for IFC entities, property sets, and datatypes, while incorporating built-in schema validation. By lowering the technical barrier for use, they enable practitioners to author IDS files more efficiently while still maintaining compliance with the standard (buildingSMART International, 2024b). Importantly, these tools are often embedded in larger BIM ecosystems, integrating IDS creation with other processes such as model coordination and issue management.

Validation of IDS requirements against IFC models is equally important. The buildingSMART IDS Audit Tool provides schema validation of IDS files to ensure structural correctness (buildingSMART International, 2024c). Similarly, libraries such as xBim.IDS.Validator enable IFC models to be checked against IDS requirements programmatically, supporting flexible integration into project-specific workflows (Lockley, 2024). In addition, established model checking environments, such as Solibri and BIMcollab Zoom, have begun integrating IDS-based validation into their broader QA frameworks, embedding IDS into clash detection and model review processes (buildingSMART International, 2024a). Empirical studies such as Cerovšek and Omar (2025) provide further evidence on the usability of IDS authoring and validation tools, highlighting the need for improved cross-referencing, semantic support, and AI-driven enhancements to scale adoption in practice.

Taken together, these standards and tools illustrate the maturing landscape that supports the transition from EIR to IDS. Manual XML editing maximises control but is inefficient and error-prone, prototype editors guarantee compliance but remain technical in nature, while commercial editors offer a more balanced solution by combining usability with compliance and embedding IDS into wider BIM workflows. Against this backdrop, the selection of an appropriate tool for the case study was informed by the need for both schema compliance and practical usability, a decision further discussed in Chapter 4.1.

4. APPLICATION AND CASE STUDY

4.1. Context and Description

The case study was designed to explore how EIR could be operationalised through IDS and subsequently tested against an IFC model for compliance. The overarching aim was to demonstrate how information requirements defined at the outset of a project can be translated into machine-readable form and systematically validated within a BIM environment.

The process began with exploratory trials, where a pre-prepared IDS file published by buildingSMART Portugal was tested and modified iteratively. These initial experiments, carried out using XML editing and various AI-supported tools, highlighted significant limitations. Repeated cycles of editing, validation, and error correction proved inefficient, with many errors stemming from discrepancies in property naming conventions, property sets, and datatype definitions. This underlined the necessity of aligning IDS requirements directly with the structure of IFC exports to ensure consistency.

In response to these challenges, the decision was made to create the IDS file from scratch rather than modifying existing templates. The usBIM IDS editor was selected as the primary tool, as it offered a structured environment for specification development, minimised syntax errors, and provided direct mapping between IFC entities, property sets, and datatypes. Compared with manual XML editing or more technical reference editors, usBIM struck a balance between usability and compliance, offering features such as drop-down selections, schema-based validation, and integration within a wider BIM ecosystem. This combination lowered the technical barrier to IDS creation while ensuring schema correctness.

Two principal sources of requirements were incorporated into the IDS. The first consisted of project-specific requirements derived from the pilot project. The second reflected BESIX company standards, which are typically consistent across different projects and therefore could be reused in future IDS files. These requirements were first organised in a LOIN template, which structured the transition from project and company specifications into verifiable IDS rules and provided a clear link between EIR clauses and model parameters.

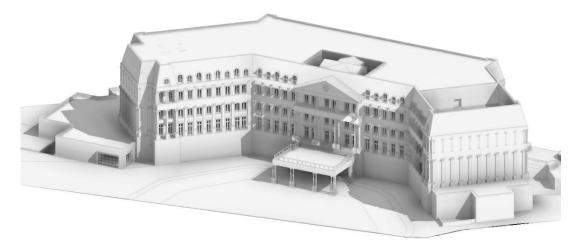


Figure 12 – 3D view of the pilot project model used for IDS validation.

4.2. Application of the Proposed Framework

The EIR defined requirements at different levels as organisational, project, and asset and structured them through Plain Language Questions (PLQs), LOIN data, and associated deliverables such as IFC models, COBie datasets, or linked documentation. Not all of these clauses were directly translatable into machine-readable form. Therefore, a distinction was made between procedural or narrative clauses, which remain outside the scope of IDS, and structured, measurable clauses, which could be encoded into the IDS and validated against the IFC model.

For example, in the PIR table, PLQ03 asked whether all statutory compliance criteria had been met at Stage 4, requiring the provision of a fire strategy and access and egress models. This requirement was interpreted in the IDS by mandating that wall elements include a FireRating property in Pset_WallCommon. In contrast, procedural requirements such as the obligation to conduct clash detection meetings or upload deliverables to the CDE on a weekly basis were recorded in the BEP but could not be converted into IDS rules, since they relate to process management rather than structured model data.

Similarly, clauses from the AIR specifying that asset data must include equipment identifiers, warranty information, and classification codes for FM integration were translatable into IDS. These were captured through rules requiring the presence of Uniclass codes and Type Mark attributes in the IFC export. Conversely, requirements about integration with the client's CAFM system or the need to conduct data import tests at handover were acknowledged but remained outside the IDS scope, as they involve workflow activities and system-level validation rather than object-level attributes.

The completed IDS file, therefore, reflects a deliberate filtering process. EIR clauses that demanded structured, model-based data, such as attributes (Name, PredefinedType), classifications (Uniclass codes), or properties (AcousticRating, ThermalTransmittance, IsExternal), were embedded into the specification. Clauses that were qualitative, narrative, or process-oriented remained within the remit of the BEP or QA/QC protocols. This distinction is crucial, as it demonstrates both the potential and the current boundaries of IDS technology.

Table 5 summarises how selected clauses from the EIR were interpreted during IDS development. It highlights the distinction between requirements that could be encoded into machine-readable rules and validated against the IFC model and those that remain narrative or procedural and must be addressed through other project protocols such as the BEP, QA/QC workflows, or CDE governance.

Table 5 – Mapping of EIR Clauses to IDS Requirements

EIR Clause (Source)	Requirement Description	IDS Expression	Translatability Status
PIR – PLQ03: "Have all statutory compliance criteria been met?"	Fire strategy and code compliance evidence	Property FireRating in Pset_WallCommon (IfcLabel)	Translatable
PIR – PLQ05: "Can FM systems be populated at handover?" Asset register with IDs, COBie dataset, classification		Uniclass classification codes, Type Mark and ID attributes	Translatable
AIR – Classification	Consistent classification for FM integration	Uniclass codes embedded in IFC	Translatable
QA/QC Clause (Section 3.6) "All issues shall be tracked in BIMcollab/Revizto."		Workflow obligation (not an object property)	Not translatable (process-related)
CDE Clause (Section 4.2) "Models must be uploaded weekly to the Shared state."		Process frequency, CDE workflow	Not translatable (procedural)
Training Clause (Section 8.1)	prove ISO 19650		Not translatable (HR/contractual)

The implementation of the framework followed a structured sequence, beginning with the definition of requirements in a LOIN template, continuing with IDS creation in the usBIM environment, and concluding with the validation of an IFC model exported from Revit.

Acting in the role of a BESIX project team member, the LOIN template was completed for the architectural elements of the pilot project. Project requirements were combined with company-specific parameters, including Uniclass classifications, Location (LBS) for levels and zones, WBS identifiers, element IDs and Type Marks, and naming conventions requiring architectural elements to begin with the prefix "ARC_". This ensured consistency with BESIX standards and provided a structured basis for the IDS rules. An extract from the LOIN template is shown in Figure 13, illustrating how wall element requirements were organised across attributes, property sets, materials, and classifications.

nimum alphanumeric informati	on requirements			
IFC class		IfcWall	lfcWall	lfcWall
Attributes		550110055555		
Name			X	X
Predefined Type		X	X	X
IfcGUID	5.	X	X	X
Property sets				
Property	Property set			
FireRating	Pset_WallCommon		X	X
AcousticRating	Pset_WallCommon		X	X
ThermalTransmittance	Pset_WallCommon		X	X
IsExternal	Pset_WallCommon	X	X	X
Length	Qto_WallBaseQuantities	X	X	X
Width	Qto_WallBaseQuantities	X	X	X
GrossSideArea	Qto_WallBaseQuantities	X	X	X
LBS	Pset_WallCommon	X	X	X
WBS	Pset_WallCommon	X	X	X
Materials				
Name	IfcMaterial		X	X
Classification				
System	Table			
UniClass	Systems	X	X	X

Figure 13 – Extract from the LOIN template showing wall element information requirements.

Following this preparation, the IDS file was created in the usBIM IDS creator, building on the tool selection rationale outlined in Section 4.1. Specifications were defined to identify the IFC elements subject to validation, and filters were applied to indicate whether particular attributes or properties were mandatory, optional, or prohibited. Each requirement was then encoded in alignment with the parameters established in the LOIN file.



Figure 14 – Extract from usBIM IDS editor showing encoded requirements for wall elements, corresponding to the structured parameters defined in the LOIN template.

Once the IDS file was completed, the Revit model of the pilot project was exported as an IFC file and uploaded into the usBIM platform for validation. Due to the high number of elements present, the model was segmented for analysis. Validation began with the basement floor, for which a filtered IFC export was generated (Figure 11). To further focus the test, a simplified version of the IDS was created that retained only the specifications relevant to wall elements. This downsized IDS was then applied to the basement model to systematically assess whether wall elements complied with the defined requirements.

The decision to begin with wall elements on the basement floor was deliberate. Walls were selected as the first category because of their fundamental role in architectural design, their high occurrence across the model, and the availability of well-established IFC property sets such as *Pset_WallCommon* and *Qto_WallBaseQuantities*. These characteristics made walls particularly suitable for initial testing, since they provided both a sufficiently large dataset for meaningful validation and a clear set of standardised properties against which requirements could be encoded.

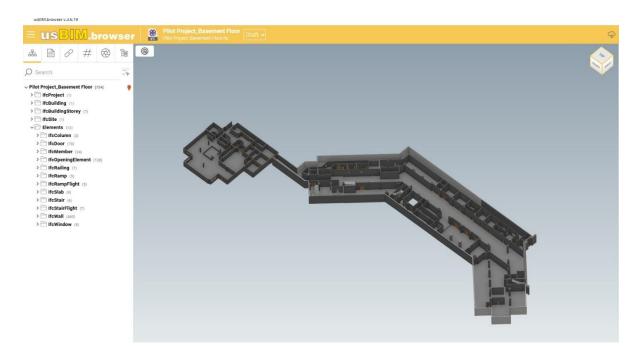


Figure 15 – IFC export of the basement floor architectural elements uploaded to the usBIM viewer for IDS validation.

Starting at the basement floor further supported a systematic approach. The basement offered a controlled subset of the overall model with a manageable number of elements, reducing the complexity of the first validation test while ensuring results remained representative. By segmenting the workflow in this way, first by floor, then by element type, the validation process mirrored the principle of *progressive information delivery* advocated in ISO 19650, where information is supplied and checked incrementally across project stages.

This segmented approach also opened the possibility of scaling the workflow beyond walls. Once the methodology was validated for walls, the same process could be extended to other architectural elements such as doors and windows, and subsequently to other components where property requirements and classification systems are more complex. Such scalability is essential for embedding IDS-based validation in practice, where different categories of elements become progressively more critical as the project advances through design and construction stages.

4.3. Evaluation Results

The validation of the basement floor's wall elements provided valuable insights into the framework's applicability. The IDS defined for walls went beyond basic identification and incorporated a

comprehensive set of requirements aligned with company standards. In addition to attributes such as Name and PredefinedType, the IDS required the presence of a Uniclass classification (pattern Ss.*), dimensional information such as Width (from Qto_WallBaseQuantities), and several properties from Pset_WallCommon, including FireRating, AcousticRating, ThermalTransmittance, and IsExternal, each linked to its appropriate IFC datatype.

The evaluation confirmed that all wall elements complied with the defined requirements. The usBIM IDS validator generated a structured issue report that classified outcomes into three categories, Error, Warning, and Info, depending on how the IFC model aligned with the IDS file. An Error indicated a violation of the specification, such as a missing mandatory property (e.g., FireRating not present), the use of an incorrect IFC class, or a misaligned classification. A Warning denoted a non-critical issue, such as schema mismatches or partially satisfied rules, which may require further review but did not compromise compliance. An Info outcome represented the successful detection of expected fields without any rule violation, in such cases, the field existed in the model, but no strict value-matching condition had been applied.

All outcomes in the basement validation were reported as Info codes, confirming that the required attributes, properties, and classifications were present. (Figure 16) Specifically, the report returned code 399 (property fields found), code 599 (classification fields found), and code 699 (attribute fields found) (Figure 17). These codes served as positive confirmations that the IFC model contained the fields specified in the IDS, and no errors or warnings were triggered.

Walls

Total elements number: 463

Number of elements with issues: 463

Code	Description	Туре	Quantity
599	Classification field found	Info	463
699	Attribute field found	Info	926
399	Property field found	Info	2315

Figure 16 – Issues report obtained from usBIM IDS validator.

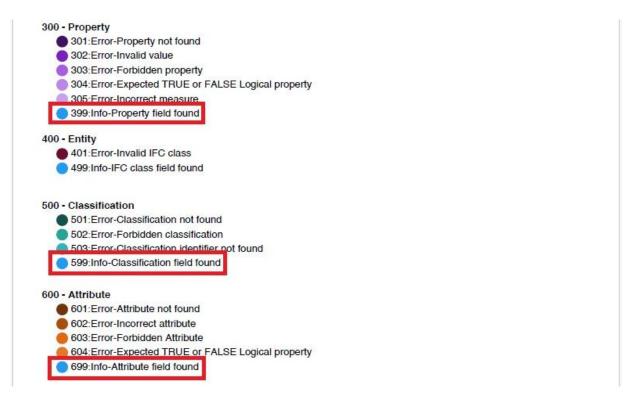


Figure 17 – Info results for wall elements (codes 399, 599, 699).

In total, 463 wall elements were validated against eight requirements, resulting in 3,704 individual compliance checks. All checks were successfully fulfilled, confirming a compliance rate of 100%. This quantitative outcome reinforced the reliability of the framework, demonstrating that the IDS not only encoded the specified requirements correctly but also that the IFC model contained the necessary data in every instance.

Table 6 - Summary of Validation Results for Basement Walls

IDS Code	Description	Count	Compliance Rate
399	Property field found	2,315	100%
599	Classification field found	463	100%
699	Attribute field found	926	100%
Total	All checks performed	3,704	100%

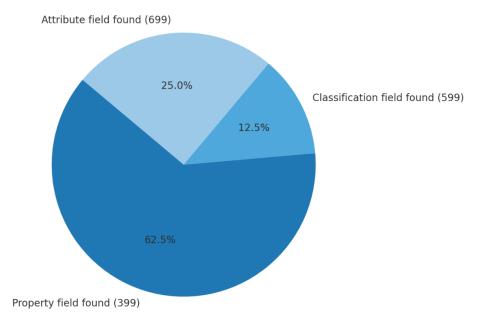


Figure 18 - Graphical summary of validation outcomes by IDS code.

Conducting validation in this segmented manner not only improved interpretability but also reflected the principle of progressive information delivery in BIM. By testing compliance incrementally, first by floor, then by element category, the process reduced complexity, enabled clear traceability of results, and created a scalable workflow that could be extended to other element types such as doors, windows, etc.

The reporting process also strengthened the reliability of the workflow. By linking each requirement to the corresponding IFC elements and categorising the results clearly, the validator produced an auditable record of compliance. Such reports can be archived within the project's CDE to provide traceability and serve as evidence during project reviews or contractual handovers.

While the evaluation was limited to wall elements of a single floor, the positive outcome demonstrated that the framework could be scaled to additional elements and stages. Moreover, the structured reporting logic provided transparency that reduced the potential for misinterpretation and reinforced the role of IDS as a reliable QA/QC mechanism.

4.4. Lessons Learned

The case study provided several lessons for the practical application of EIR-to-IDS workflows and IDS-based validation.

First, it highlighted the critical importance of a well-structured LOIN template. By systematically defining requirements and embedding both project-specific and company-wide parameters, the transition to IDS creation was streamlined and the risk of misalignment with the IFC model was significantly reduced.

Second, the study reinforced the value of tool selection. The usBIM IDS creator, with its user-friendly interface, schema compliance checks, and integration with wider BIM workflows, reduced the technical

barrier associated with XML editing and demonstrated how automated validation can be made accessible to practitioners without programming expertise.

Third, the strategy of segmenting the validation proved effective. By restricting the process to specific elements and floors, results were easier to interpret, more systematic, and less prone to oversight. This incremental approach mirrors how quality assurance is often conducted in practice, where checks are performed progressively rather than through a single, exhaustive review.

Fourth, the evaluation demonstrated the analytical strength of automated validation. The ability to perform 3,704 individual checks on wall elements with 100% compliance provided clear evidence of the scalability and reliability of IDS-based validation. This quantitative perspective reinforced the notion that automated approaches can deliver results with a level of precision and consistency that would be difficult to achieve through manual QA/QC processes alone.

From a practitioner's perspective, the case study demonstrated clear implications for how IDS could be applied within BESIX projects. By automating compliance checking, IDS has the potential to significantly reduce the time and effort required for manual QA/QC, particularly for high-volume checks such as verifying classifications, attributes, and naming conventions. This efficiency gain would allow BIM coordinators and QA leads to focus their expertise on more complex issues, such as interdisciplinary coordination or qualitative review tasks, rather than repetitive data validation. At the same time, the results highlighted that IDS cannot yet eliminate the need for human oversight, since narrative requirements and procedural clauses remain outside its scope. This suggests that the practical role of IDS should be understood as a complement to, rather than a replacement for, existing QA/QC processes at BESIX.

Finally, the findings emphasised both the opportunities and the limitations of IDS in its current form. As discussed in Chapter 3, narrative or procedural clauses, for example, those instructing how often models should be uploaded to the CDE or requiring models to be "easy to understand", remain outside the scope of machine-readable logic. This confirmed that while IDS offers significant value in automating compliance checking of model-based requirements, its scope is inherently limited. Consequently, IDS should be applied in parallel with complementary processes defined in the BEP and QA/QC protocols, ensuring that both structured data and procedural requirements are addressed comprehensively.

The mapping exercise between the EIR clauses and IDS requirements further reinforced this observation. As shown in Table 5, structured and measurable clauses, such as those requiring FireRating properties or Uniclass classifications, were successfully embedded into the IDS and validated against the IFC model. By contrast, narrative or procedural clauses, including those concerning CDE workflows, issue tracking, or training responsibilities, could not be translated into machine-readable rules. This confirmed that while IDS offers significant value in automating compliance checking of model-based requirements, its scope is inherently limited. Consequently, IDS should be applied in parallel with complementary processes defined in the BEP and QA/QC protocols, ensuring that both structured data and procedural requirements are addressed comprehensively.

Another important lesson concerns the future usability of IDS within BESIX. The IDS created for architectural elements in this case study can serve as a reusable template, forming a baseline that can be adapted for other projects with only minor adjustments for project-specific data. This approach would enable the company to build a growing library of IDS files covering different element categories, progressively reducing the effort required to establish information requirements at the outset of each project. Such scalability strengthens the argument for formalising the EIR-to-IDS workflow within the company, as it demonstrates how investment in a structured template today can deliver long-term efficiency and consistency across multiple projects.

5. QUALITATIVE DATA COLLECTION AND FEEDBACK

This chapter presents the qualitative data collection process carried out to evaluate and refine the EIR template developed for BESIX. The feedback was gathered in two main phases: exploratory insights obtained through a series of semi-structured meetings with company representatives, and validation insights collected through a structured survey circulated to BIM managers and coordinators. These were supplemented by additional feedback provided outside of the formal process, including an application of the template in a live tender and expressions of interest in its potential broader use. Together, these multiple forms of input provided a comprehensive understanding of both the strengths and limitations of the fillable EIR template.

5.1. Semi-Structured Interviews

Six semi-structured meetings were conducted with two designated company representatives over the course of the development process. Although the intention was to hold these meetings bi-weekly, this schedule could not always be maintained due to workload constraints. Nonetheless, the regular exchanges provided an iterative cycle of feedback that shaped the evolution of the work.

In the early meetings, the discussions centred on understanding existing company standards and information management practices. This allowed for the identification of gaps and challenges in their current workflows and also informed the eventual narrowing of the dissertation focus. Once the focus on EIR template development had been jointly established, subsequent meetings largely consisted of progress presentations on the template draft followed by feedback from the company representatives.

A recurrent issue raised during these meetings was the tension between creating a formally comprehensive EIR document and ensuring that it remained accessible for daily project use. The comprehensive version, while strong as a contractual reference, was deemed too complex for widespread operational adoption. In response, it was agreed to produce a simplified fillable version of the EIR. This document-maintained compliance with ISO 19650 but presented the requirements through a structured, colour-coded set of tables, explanatory notes, and examples designed for ease of completion.

The practicality of the fillable version was tested by one BIM manager in the context of a new tender, who subsequently provided extensive feedback. This review went beyond a simple confirmation of usability and offered detailed observations on both the strengths of the template and its limitations when applied in practice. The feedback highlighted its overall applicability while also identifying areas requiring adaptation, such as the absence of tender-specific fields, the assumption of complete information at early project stages, and the lack of revision history or approval workflow.

The manager also highlighted that certain fields assumed information availability that was unrealistic at early project stages. Examples included LOIN definitions, which are often finalised only post-contract, and security tier scoring, which requires client input that may be delayed. Similarly, training and competency data were described as frequently incomplete or outdated at the outset. To mitigate this, the manager proposed adding a column in key tables (such as AIR, PIR, and KPI) to track both the expected

source of information and its availability status. These observations were summarised in a structured evaluation table provided by the manager.

Table 7 – Evaluation of Fillable EIR Template in Live Tender Context (received from the BIM manager at BESIX)

Criterion	Assessment	Notes
Structure & ISO compliance	Excellent	Fully aligned with ISO 19650
Applicability to live tenders	Good	Needs tender-specific fields
Information completeness	Moderate	Some data may not be available early.
Contractual robustness	Good	Add versioning and approval.
Usability	Strong	Clear layout and guidance

This feedback was particularly valuable, as it demonstrated how the template performed in a real project environment rather than in theoretical discussion. It confirmed its usability but also revealed practical gaps that would need to be addressed for contractual and tendering contexts.

5.2. Form/Survey Results

Following the pilot test, the fillable EIR template was distributed to thirteen BIM managers and coordinators, of whom six completed the feedback survey. The survey was designed to capture structured evaluations of the document across three main dimensions: ease of use, alignment with current company BIM processes, and the likelihood of recommending the template for future projects.

The numerical ratings showed generally positive reception, with most responses positioned at the upper end of the scale. Usability was rated favourably, and the majority of participants indicated that the template aligned reasonably well with existing company processes. The willingness to recommend the template for future projects was also confirmed in several responses (Figure 19).

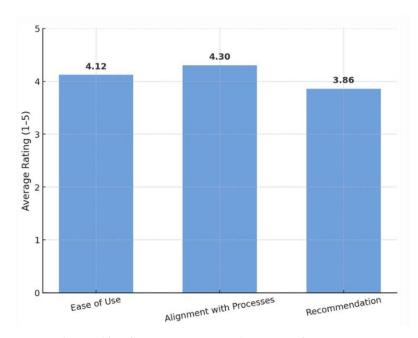


Figure 19 – Survey Results – Average of the scores.

However, the open feedback revealed nuances that the numerical ratings alone did not capture. Several respondents highlighted readability issues, particularly in relation to the use of abbreviations such as PLQ, OIR, and RIBA, which were defined only at the end of the document. One manager noted that "the amount of new abbreviations makes it difficult to read for me," indicating that the inclusion of clearer explanations or more immediate definitions would improve accessibility. This observation suggests that even professionals actively engaged in BIM-related projects may not always be fully familiar with specialised terminology, reinforcing the need for supportive explanatory content.

Another manager pointed out that the table-heavy structure, while systematic and clear, limited contextual understanding. They suggested that "a diagram explaining the relations between all the tables could be helpful, a picture says more than 1000 words." This proposal is valuable, as visual representation could enhance comprehension of the relationships between requirements. Nonetheless, its applicability remains uncertain, since the deliberate use of tables was intended to keep the template straightforward and easily fillable. The challenge, therefore, lies in striking an effective balance between the clarity and practicality offered by the table-based format and the need for additional visual or narrative elements to ensure that the document remains accessible to a wider range of users.

Several constructive proposals were also provided, reflecting a forward-looking approach by the respondents. One suggestion was to develop the template into a dashboard-style tool that could be continuously updated and used to track responsibilities and progress. Such a transformation would not only enhance usability but also integrate the template more directly into digital project workflows, thereby reducing the risk of it becoming a static document. Another proposal emphasised the importance of localisation, recommending that the template be adapted to align with national standards. This would strengthen its relevance in different regulatory and contractual contexts and increase its potential for adoption beyond the company's immediate environment. In addition, respondents highlighted the need to expand the scope of examples included in the template, particularly by covering additional disciplines such as mechanical, electrical, and HVAC systems. This would ensure that the document reflects the multidisciplinary nature of BIM projects and provide clearer guidance to a broader set of users.

The survey thus confirmed both the value and the limitations of the template. It demonstrated that the structure was appreciated and seen as functional, but also that further refinement was needed to improve readability, contextual fit, and adaptability.

Beyond the survey, an additional form of feedback contributed to the evaluation. One BIM manager expressed interest in sharing the template with an external national workgroup dedicated to BIM protocols and execution planning. Although this remark did not constitute a direct assessment of the template's structure or usability, it nevertheless carried significance. It demonstrated that the document was regarded not only as relevant within the company but also as having potential value for broader industry discussions.

5.3. Interpretative Findings

The qualitative data gathered through semi-structured meetings, survey responses, and additional manager input provided a comprehensive evaluation of the developed EIR template. The findings highlighted the template's strengths in terms of structure, systematic presentation, and overall usability, while also exposing limitations related to readability, contextual adaptation, and practical application in early project phases.

A consistent theme across all feedback sources was the need to balance formal compliance with practical usability. The survey underscored the importance of readability and contextual support, while the live tender feedback revealed the necessity of integrating mechanisms to track information availability and introduce revision workflows. Meanwhile, the external interest expressed suggested that the template holds potential beyond the immediate scope of BESIX projects.

These insights have direct implications for the dissertation's overarching aim. The identified challenges, terminological clarity, role adaptation, and the management of incomplete or evolving information, are the very issues that complicate the translation of narrative EIRs into machine-readable IDS. Similarly, the suggestions for dashboards and structured workflows point towards the digitalisation of EIRs, which is essential for enabling automated compliance checking and QA/QC processes.

In conclusion, the qualitative data collection confirmed the practical value of the fillable EIR template while also providing a roadmap for its continued refinement. It demonstrated that developing an EIR is not only a matter of technical alignment with ISO standards but also of ensuring usability, adaptability, and readiness for digital transformation. These findings form the basis for the broader reflections presented in the following chapter, where the main developments, implications, and future directions of this research are synthesised.

6. CONCLUSIONS

This dissertation set out to address the lack of standardisation and verifiability in information requirements for BIM-based quality management. Through the development of a contractor-oriented EIR template and its translation into IDS, the research demonstrated how structured information definition can improve both project initiation and downstream quality assurance processes. The study combined literature insights, industry benchmarking, case study validation, and stakeholder feedback, providing a comprehensive evaluation of the proposed framework.

The first significant development was the design of a structured EIR template tailored to the needs of contractors. Unlike generic templates that often lack practical usability, this version was modular, fillable, and adaptable to different project contexts. It embedded QA/QC requirements explicitly within information blocks and ensured alignment with ISO 19650 principles. In this way, the EIR was shown to act as the foundation of a robust QA/QC process, defining what quality means in a project by making requirements explicit, structured, and traceable.

The second development was the demonstration of how selected clauses from the EIR could be translated into a machine-readable IDS. This confirmed that requirements expressed in structured terms, such as property presence, classification, and attribute definitions, can be automatically validated against IFC models with precision and scalability. At the same time, the exercise revealed that narrative or procedural clauses cannot yet be formalised into machine-readable logic, making human oversight and complementary processes necessary.

The third outcome was the collection of stakeholder validation through interviews, surveys, and a live tender application. This feedback confirmed the framework's practical relevance while highlighting the need for improved readability, contextual adaptation, and digital integration. Proposals for dashboard-style tracking, localisation to national standards, and extension to multidisciplinary requirements underscored both the opportunities and challenges for wider adoption.

Despite these achievements, the study faced limitations. The validation was constrained to a single contractor context and to a narrow IDS coverage focused on architectural wall elements. Broader testing across disciplines, projects, and organisations is needed before generalising the framework. Moreover, IDS remains limited in handling narrative or cross-object logic, which restricts its applicability for comprehensive QA/QC.

Looking forward, several directions for development remain open. Expanding IDS coverage to structural, MEP, and infrastructure models would strengthen applicability. Integrating the EIR template into dashboards and CDE platforms would respond to stakeholder calls for real-time usability Exploring AI-driven requirement parsing and NLP-based validation could further address the current limits of machine readability. Finally, institutionalising EIR-to-IDS workflows at the organisational level would allow contractors to build reusable requirement libraries, progressively increasing efficiency and maturity in quality management.

In conclusion, this dissertation intended to provide a structured, practical, and forward-looking approach to information requirement management in BIM. The research provides contractors with a replicable

and forward-looking framework that not only addresses ambiguity and inefficiency in project initiation but also supports the industry's transition towards verifiable, interoperable, and scalable digital quality workflows. Beyond BESIX, the contribution lies in evidencing how structured requirement definition and machine-readable verification can advance both industry practice and academic research in digital construction.

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APPENDICES

APPENDIX 1: PROPOSED EIR TEMPLATE

1. INTRODUCTION

This Exchange Information Requirements (EIR) document outlines the Appointing Party's expectations regarding the production, management and delivery of project information in accordance with the ISO 19650 series. It forms part of the contract documentation and must be responded to via the BIM Execution Plan (BEP). This document applies throughout the asset lifecycle, supporting design, construction and operational phases. Its purpose is to ensure that the right information is delivered at the right time to support key decisions, risk management and asset performance.

The framework presented here is scalable and flexible, allowing it to be tailored to projects of different sizes, levels of complexity, and team capabilities. It is based on recognised best practice and aligned with ISO 19650 standards, while acknowledging potential challenges in practical application, such as limited resources, interoperability issues between tools, uneven BIM adoption across stakeholders, and varying levels of client maturity. These factors shall be considered within the BEP, which must record any agreed adjustments to responsibilities, workflows, or deliverables to ensure both compliance and project viability.

Project phase definitions in this EIR follow the RIBA Plan of Work. All references to "stages" in project documentation are to be interpreted in accordance with the stage numbering and naming provided in Section 2.2.5.

2. INFORMATION REQUIREMENTS

Information shall be delivered in alignment with the Appointing Party's:

- · Organisational Information Requirements (OIR),
- · Project Information Requirements (PIR) and
- Asset Information Requirements (AIR), where applicable.

Each information exchange shall respond to the defined Plain Language Questions (PLQs) and align with project stage gateways. Information shall be structured and scheduled in accordance with the project's agreed information delivery planning documents (e.g., the Master Information Delivery Plan (MIDP) and Task Information Delivery Plans (TIDPs), or equivalent planning tools as defined in the latest ISO 19650 guidance). Responsibilities, delivery formats (e.g., native files, IFC, COBie, PDF, XLSX), and approval workflows shall be clearly assigned and documented.

2.1. Organisational Information Requirements (OIR)

The Organisational Information Requirements (OIR) define the long-term information needs of the Appointing Party to support its strategic, operational and asset management goals. These requirements inform the definition of Project Information Requirements (PIR) and Asset Information Requirements (AIR), ensuring that project deliverables are aligned with the organisation's wider business outcomes.

This section is developed in accordance with ISO 19650-1:2018 Clause 5.1 and serves as the foundation for structured information delivery across all lifecycle phases.

A KPI Reporting Template is provided in Appendix 3 to support the consistent recording and monitoring of performance metrics throughout the project.

2.1.1. Strategic Information Needs

The OIR reflects the Appointing Party's intention to:

- · Operate and maintain built assets efficiently using structured digital data,
- · Comply with internal policies on environmental, safety and energy performance,
- Support lifecycle costing, planned maintenance and future capital planning,
- · Integrate built asset data into existing organisational asset systems (e.g., CAFM, CMMS, ERP),
- Enable portfolio-wide analysis and benchmarking of asset performance.

2.1.2. OIR Categories

Table 1 - OIR Categories

OIR Category Description		Typical Source	Priority
Space Utilisation	Area, occupancy, zoning requirements	Architectural model, space schedule	High
Asset Lifecycle Costing	CAPEX and OPEX inputs for financial models	Cost plans, FM data, COBie	High
Maintenance & FM	Component IDs, maintenance intervals, warranties	Manufacturer data, COBie, O&M manuals	High
Regulatory Compliance	Fire, accessibility, energy compliance evidence	Reports, model validation files	Medium
Carbon & Energy Performance	Operational carbon and energy targets tracking	Sustainability reports, digital twin feeds	Medium
Risk and Security Spatial risk zones, access control points, BASIR-aligned data		Risk plans, spatial zoning layers	Medium

2.1.3. Application to The Project

For the project, the OIR impacts the following:

- The Project Information Requirements (PIR) will include PLQs related to space efficiency, life-cycle costing and digital FM readiness.
- The Asset Information Requirements (AIR) will require structured deliverables in COBie and IFC format to populate the organisation's FM systems.
- Information at each stage must be validated against these organisational goals, as reflected in the BEP and MIDP.

2.1.4. Alignment and Review

The OIR must be:

- · Reviewed at the start of the project to ensure alignment with project scope,
- · Used to guide the definition of PLQs and IDP development,
- · Revalidated prior to handover to confirm that AIM deliverables meet strategic needs.

2.2. Organisational Information Requirements (OIR)

The Project Information Requirements (PIR) define the information the Appointing Party needs at key decision points throughout the project lifecycle to support effective decision-making, risk management, statutory compliance and future asset operation.

This PIR aligns with the overarching Organisational Information Requirements (OIR) and is developed in accordance with ISO 19650-1:2018, Clause 5 and relevant guidance in BS EN 17412-1 on Level of Information Need.

2.2.1. Alignment and Review

BESIX

2.2.2. Commercial name of the project

. . . .

2.2.3. Project scope

...

2.2.4. Purposes for which the information will be used by Appointing Party

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2.2.5. Stages

The project shall follow the RIBA Plan of Work stages as defined below. The start and end dates for each stage shall be confirmed in the BEP and maintained in the project master schedule.

- Stage 0: Strategic Definition DD/MM/YYYY DD/MM/YYYY.
- Stage 1: Preparation and Briefing DD/MM/YYYY DD/MM/YYYY.
- Stage 2: Concept Design DD/MM/YYYY DD/MM/YYYY.
- Stage 3: Spatial Coordination DD/MM/YYYY DD/MM/YYYY.
- Stage 4: Technical Design DD/MM/YYYY DD/MM/YYYY.
- Stage 5: Manufacturing and Construction DD/MM/YYYY DD/MM/YYYY.
- Stage 6: Handover DD/MM/YYYY DD/MM/YYYY.
- Stage 7: Use Post-occupancy stage activities as defined in the Asset Management Strategy.

2.2.6. Structure

The PIR is structured around:

- · Project stage milestones (RIBA Plan of Work 2020 should be followed for the project stages),
- · Related Plain Language Questions (PLQs),
- · Information exchanges (models, documents, data),
- · Responsibility assignments (who delivers what and when).

2.2.7. PIR Table

Table 2 - Plain Language Questions

PLQ Ref	PLQ	Stage	Required Info	Format	Discipline
PLQ01	Can the site strategy accommodate the functional program?	Stage 2 – Concept Design	Site layout, zoning plan, parking analysis	PDF, DWG, IFC	Architecture
PLQ02	Is the proposed structural scheme compatible with architectural intent?	Stage 3 – Spatial Coordination	Structural grid, structural model with coordination zones	IFC, PDF	Structure
PLQ03	Have all statutory compliance criteria been met?	Stage 4 – Technical Design	Fire strategy, access & egress models, code check reports	PDF, BCF, XLSX	Multidisciplinary
PLQ04	Are the building services spatially coordinated and energy targets met?	Stage 4 – Technical Design	MEP coordination model, energy model summary	IFC, XLSX	MEP
PLQ05	Can FM systems be populated at handover?	Stage 6 – Handover	Asset register, COBie dataset, O&M manuals	COBie, PDF	All disciplines

2.2.8. Notes

- Each PLQ should be answered through clearly defined information deliverables aligned with the Information Delivery Plan (IDP).
- · PLQs are not exhaustive; additional ones may be introduced based on emerging project needs.
- The format and metadata of deliverables must conform to the requirements in sections 3.1 and 3.2 of this EIR.

2.3. Asset Information Requirements (AIR)

2.3.1. Purpose

The Asset Information Requirements (AIR) define the specific information needed about an asset or facility to support its effective operation, maintenance, and lifecycle management. These requirements apply primarily at project handover and throughout the asset's use phase and must be met by structured deliverables that enable integration into the Appointing Party's Facility or Asset Management systems (CAFM/CMMS/ERP).

The AIR forms part of the overall information strategy and is informed by the Organisational Information Requirements (OIR).

2.3.2. Scope of AIR

The AIR applies to all physical and functional components of the built asset that will be:

- · Maintained,
- · Replaced,
- · Monitored,
- · Re-commissioned, or decommissioned during the asset's operational lifecycle.

It includes spatial, environmental, structural, MEP and asset tagging information required by the Appointing Party.

2.3.3. AIR Data Structure and Format

All asset information shall be delivered using the following structured formats:

Table 3 - AIR Data Structure and Format

Data Type	Format	Standard Reference	Example
Geometric and spatial info	IFC 4.3	ISO 16739-1	Room boundaries, zones
Asset register	COBie (Excel or JSON)	BS 1192-4:2014	AHUs, lights, pumps
Documentation links	PDF (linked in COBie)	ISO 19650-3 Clause 7.4	O&M manuals, warranties
Equipment IDs	Uniclass2015 codes (Ss, Pr)	ISO 12006-2	Ss_55_10_70, Pr_70_70_88_31
Classification metadata	Embedded in IFC	ISO 23386 / 23387	Pset_ManufacturerTypeInformation

2.3.4. Level of Information Need Data Collection

To support the definition and verification of the LOIN for each deliverable, a separate LOIN Data Collection Form is provided alongside this EIR. This form must be completed by the Lead Appointed Party, in coordination with all relevant Task Teams, and submitted to the Appointing Party for approval at the precontract stage. The approved form will serve as the basis for IDS and will be used to validate IFC exports during project delivery. The completed and approved LOIN Data Collection Form shall be maintained as a live document throughout the project lifecycle.

2.3.5. AIR Categories and Requirements

Table 4 - AIR Categories and Requirements

Category	Key Information	Target Format	Validation Method
Spaces & Zones	Room name, usage type, GIA/NIA, occupancy	IFC + COBie.Space	IFC spatial hierarchy, LOIN check
Systems & Equipment	ID, type, serial no., location, warranty, maintenance schedule	COBie.Component + COBie.System	IDS validation + visual QA
Documentation	As-builts, specs, certificates, test data	Linked PDF	Document review
Energy Performance	System ratings, energy source, carbon data	COBie.Type + custom attributes	Template match
Maintenance	Frequency, responsible team, first service date	COBie.Job	QA log against FM requirements

2.3.6. Integration with Organisational Asset Management System

All information must be compatible with the organisational asset system that has been used.

COBie and IFC deliverables will be tested using open-source and proprietary tools (e.g., BIMcollab, BIM 360, IDS Validator).

Data import testing will occur in Stage 5-6 using a validation sandbox environment.

2.3.7. Handover Requirements and Acceptance

Final asset information deliverables must:

- · Be complete, validated and delivered prior to handover,
- · Be reviewed using a structured QA checklist and other rating system,
- · Include a sign-off form per system or package.
- Only accepted data will be integrated into the Appointing Party's operational systems.

2.3.8. Governance and Review The AIR is owned by the Appointing Party's Facilities/Asset Management team. • It must be reviewed at project initiation and updated in parallel with the MIDP. · Changes must be logged and approved in the project's change control register.

3. MANAGEMENT / STANDARDS / ROLES

3.1. Applicable Standards and Protocols

All project participants are required to adopt and comply with the following standards and guidelines throughout the delivery and management of information:

- ISO 19650-1 to ISO 19650-5 Organisation and digitization of information about buildings and civil engineering works, including building information modelling (BIM)
- ISO 16739-1 Industry Foundation Classes (IFC) schema for openBIM data exchange
- . ISO 12006-2 Framework for classification systems used in construction
- . ISO 7817-1:2024- Level of Information Need (LOIN) specification
- ISO 19650-4 Structured information exchange during the delivery phase (e.g., COBie, IFC-based data outputs)
- ISO 29481-1 Information Delivery Manual (IDM)

Where local regulations or organisational protocols exist (e.g., national BIM mandates), they must be followed in conjunction with the above international standards.

All file naming, container metadata and CDE workflows must be structured in accordance with ISO 19650-2, Clause 5.1.4 and the project's approved information naming conventions.

3.2. Roles and Responsibilities

The following roles must be defined, appointed and documented in the BIM Execution Plan (BEP). Each role shall be aligned with the responsibilities described in ISO 19650-2 Clause 5.2 and must be traceable through the Responsibility Assignment Matrix (RAM):

3.2.1. Appointing Party Roles

 Appointing Party Information Manager / BIM Manager: Responsible for defining the Exchange Information Requirements (EIR), validating pre- and post-contract BEPs, reviewing information exchanges and ensuring project deliverables meet OIR/PIR/AIR.

3.2.2. Lead Appointed Party Roles

- Lead Appointed Party Information Manager: Coordinates information production activities
 across all task teams, compiles the Master Information Delivery Plan (MIDP), and oversees CDE
 compliance.
- Design Coordinator / Lead Designer (if applicable): Responsible for coordination between design disciplines and model federation.

3.2.3. Task Team Roles

- Task Team Information Managers / BIM Coordinators: Ensure discipline-specific modeling
 complies with the agreed standards and that deliverables are validated against the project's
 Information Delivery Plans (IDPs).
- Modellers / Authors: Responsible for producing geometry and data within discipline models and following the LOIN and classification expectations.

3.2.4. Security and Compliance

 Built Asset Security Manager (if required): Appointed per ISO 19650-5 for projects with security sensitivity. Manages BASIR requirements, access control strategy and incident protocols.

All roles and their interactions must be mapped in the Project Information Management Workflow diagram and reflected in:

- · BEP Section 3: Project Organisation and Responsibilities,
- The Information Management Assignment Matrix.

3.3. Coordination and Approval Responsibilities

In this project, BESIX, acting as the Appointing Party, assumes the BIM Manager role and is responsible for the overall strategic coordination of information management processes. The detailed coordination tasks, including model federation, clash detection and issue tracking, shall be executed by the Lead Appointed Party, under the oversight of the BESIX BIM Manager.

"The Lead Appointed Party must appoint a qualified individual responsible for model coordination, capable of evaluating and resolving interdisciplinary conflicts in alignment with the project's quality and delivery requirements."

Accordingly, the Lead Appointed Party must:

- Create and maintain a federated model, integrating design authoring models from all appointed
 parties and ensuring that updates are aligned with the project's model delivery schedule.
- Execute clash detection procedures using approved tools (e.g., Navisworks, Revizto) and generate
 clash reports in accordance with the project's Model Coordination Strategy.
- Organise and lead regular coordination meetings to present clash detection findings, assign issue ownership and monitor issue resolution.
- Use BCF-compatible tools or CDE-integrated issue management systems to track model issues.
 All coordination issues must be logged, updated and closed according to the QA process outlined in the BEP.
- Report progress to the BESIX BIM Manager on a regular basis, highlighting critical coordination risks, unresolved issues and proposed resolutions.

BESIX, as the BIM Manager, retains responsibility for:

- · Reviewing and validating the coordination model prior to key data drops.
- Ensuring alignment between model coordination activities and information requirements defined in this EIR.
- Auditing issue resolution logs and verifying that coordination deliverables comply with defined Quality Assurance and Quality Control (QA/QC) criteria.

All coordination procedures must be detailed in the BEP and integrated with the project's Common Data Environment (CDE) approval workflows.

3.4. Role Scaling and Resource Adaptation

- The allocation of Information Management roles (as defined in ISO 19650-2 Clause 5.1.7) shall be based on project complexity, size, and the maturity of the project team.
- Where dedicated roles cannot be assigned due to resource constraints, responsibilities shall be merged, with the redistributed tasks clearly defined in the BEP's Responsibility Assignment Matrix (RAM).
- The Lead Appointed Party shall ensure that all EIR requirements remain fulfilled regardless of role consolidation.
- Any deviations from the standard role structure shall be documented in the BEP and approved by the Appointing Party prior to project commencement.

Table 5 - Roles Scaling

Project Type	Typical Role Coverage	Notes	
	Full ISO 19650 role structure: Appointing Party		
Large / Complex	Information Manager, Lead Appointed Party Information Manager, Task Team Managers, QA Lead, CDE	Clear separation of authoring, QA, and coordination tasks	
Medium	Administrator, Model Authors Some roles combined (e.g., Task Team Manager doubles as OA Lead)	Role combinations must be documented in BEP RAM	
Small / Simple	Multiple roles merged (e.g., one BIM Coordinator handles authoring, QA, and CDE admin)	Higher risk of conflict of interest, QA review should be carried out by another project team where possible	

3.4.1. Determining Project Team Size

For the purposes of this EIR, project team sizes are classified as **Small**, **Medium**, or **Large**. The classification shall be determined by the Appointing Party during project mobilisation and documented in the BEP. The assessment shall be based on the criteria described in the following table.

Table 6 - Team Size Criteria

Criteria	Small Team	Medium Team	Large Team
Project Value	<€10 million	€10–50 million	> €50 million
Disciplines Involved	≤ 3 disciplines	4–6 disciplines	> 6 disciplines
BIM Requirements	Basic modelling, minimal coordination	Federated model with coordination	High LOIN, multiple exchanges, advanced QA/QC
Stakeholders	≤ 5 organisations	6-10 organisations	> 10 organisations
Project Duration	< 12 months	12-24 months	> 24 months

Note: Where criteria span multiple classifications, the final classification shall be determined by the Appointing Party based on overall project complexity and risk. This classification will directly influence the Responsibility Assignment Matrix (RAM) and associated role definitions in the BEP.

3.5. Responsibility Assignment Matrix (RAM)

The table below outlines the responsibility assignments for key information management activities across the project lifecycle. It ensures clarity of duties in alignment with ISO 19650-2 Clause 5.2 and supports the development of the BEP.

The matrix uses the RACI model to define:

- R Responsible
- A Accountable
- C Consulted
- I − Informed

The RAM must be reviewed and agreed upon during the tender stage and updated as part of the pre-contract BEP.

Table 7 - RAM (Large Team)

Deliverable / Task	Appointing Party	Lead Appointed Party	Task Team Manager	Information Manager	Discipline Author
Define EIR	R	С	5 5	装	
Develop Pre-Contract BEP	С	R	A	A	
Submit TIDP	879	С	R	A	
Validate IFC export	879	A	С	R	R
Perform Clash Detection	8*3	R	A	С	C
Submit COBie at Handover	9*9	A	С	R	R

In accordance with Section 3.4 Role Scaling and Resource Adaptation, the following Medium and Small Team Responsibility Assignment Matrix provides an example of how roles may be merged for projects with limited BIM resources, lower complexity, or smaller delivery teams. This matrix shall only be applied where approved by the Appointing Party and documented in the BEP.

Table 8 - RAM (Medium Team)

Deliverable / Task	Appointing Party	Lead Appointed Party	Information Manager	Task Team Manager / Discipline Author
Define EIR	R	C	(#0	*
Develop Pre-Contract BEP	C	R	A	20
Submit TIDP	300	C	R	A
Validate IFC export	72	A	С	R
Perform Clash Detection	875	R	A	C
Submit COBie at Handover	2	A	C	R

Table 9 - RAM (Small Team)

Deliverable / Task	Appointing Party	Lead Appointed Party / Information Manager	Discipline Author (incl. Task Team Manager)
Define EIR	R	С	
Develop Pre-Contract BEP	С	R	A
Submit TIDP	āt .	С	R
Validate IFC export	Ϋ́.	A	R
Perform Clash Detection	E.	R	С
Submit COBie at Handover	¥	A	R

Where resources permit, the Large Team Responsibility Assignment Matrix should be used as the default structure.

3.6. QA/QC and Issue Management

All information deliverables shall be subject to a structured QA/QC process, combining model-based checks with on-site inspections. The following requirements apply:

- Issue Tracking Platform: All design coordination issues, data validation findings, and field QA
 observations shall be logged in a model-linked issue tracking environment such as Autodesk ACC
 Build, Revizto, BIMcollab, or an equivalent approved by the Appointing Party.
- Issue Content: Each issue shall include:
 - o Reference to the relevant model element (GUID where applicable),
 - o Description and classification,
 - Assigned responsible party,
 - Target resolution date and closure status.
- Workflow Integration: The issue tracking environment shall be linked to the project CDE where
 possible, ensuring that:
 - Deliverables cannot progress from "Shared" to "Published" without resolution of all critical issues,
 - QA reports from the tracking platform are stored in the CDE as part of the approval process.
- Field QA Integration: On-site inspections and commissioning checks shall be captured in the same
 or an integrated platform, allowing direct comparison between as-built model data and physical asset
 condition.
- Meeting Integration: Issue status shall be reviewed at coordination and QA meetings, with unresolved items tracked until closure.

4. COMMON DATA ENVIRONMENT (CDE)

4.1. Purpose and Scope

The Common Data Environment (CDE) shall serve as the single source of truth for all project information. It must be used for the management, sharing and approval of all digital deliverables across all information states, in accordance with ISO 19650-1 Clause 11.2 and ISO 19650-2 Clause 5.1.4.

4.2. CDE Requirements and Information States

The appointed party must implement and operate a secure, standards-compliant Common Data Environment (CDE) in accordance with ISO 19650 series. Where BESIX acts as the BIM Manager or Appointing Party, dual CDE platforms may be used for internal and external coordination.

CDE01 - Information States and Transitions

The CDE must support the following information states, as defined in ISO 19650:

Table 10 - Information Stages

State	Description
Work In Progress (WIP)	Local or internal development; accessible only by authoring teams.
Shared	Information verified for coordination purposes; accessible by project stakeholders.
Published	Verified and approved information used for final outputs and decision-making.
Archive	Immutable, time-stamped record of previous data states for audit purposes.

All transitions between states must be managed through approval workflows incorporating versioning, metadata, status and suitability codes, and traceable authorisation.

CDE02 - Dual CDE Usage

On projects where BESIX manages BIM processes:

- An internal CDE (e.g. Autodesk BIM 360) will be used by BESIX and its subcontractors for coordination and pre-approval workflows.
- A client-designated CDE (e.g. Batiwork) will be used for final information delivery after internal
 approval.

CDE03 - Internal CDE Workflow

Subcontractors shall upload WIP models to their assigned area in the BESIX CDE.

- When a deliverable is ready for review, the subcontractor must move the file to the Shared area for coordination.
- BESIX will conduct technical and compliance reviews. Feedback will be issued and issues must be
 resolved within the BESIX platform.
- Once approved by BESIX, subcontractors are authorised to publish the file to the client's CDE.

CDE04 - External CDE Workflow

- · Files uploaded to the client CDE must reflect the final, approved versions as validated by BESIX.
- Published information will undergo a separate client-side review process in accordance with the client's approval protocols.

CDE05 - Governance and Auditability

- · Both CDE platforms must ensure access control, audit trails, version control, and change tracking.
- The approval and release workflows must be documented in the BEP and comply with ISO 19650-2 requirements.

Each CDE must support traceability, access control, and approval tracking as required under ISO 19650. The workflows governing these transitions must be detailed in the BEP and aligned with the information container metadata conventions.

4.3. Naming Conventions and Metadata

All information containers must follow the naming structure below:

ProjectCode-Originator-Subdiscipline-DocumentType-Location-LevelZone-Number

Example: BRA01-AAA-AAA-AAA-XXA-000000

Additional metadata fields must include:

- Status code (e.g., S0, S1, A1, A2),
- · Suitability (e.g., "For Coordination", "For Construction"),
- Author, Checker, and Approver,
- Revision code and issue date.

These rules shall be detailed in the BEP and supported with a Naming Convention Guide, which must be reviewed and approved at project kickoff.

4.4. CDE Platform and Responsibilities

The Lead Appointed Party must:

· Propose the specific CDE platform to be used in the pre-contract BEP,

- Confirm that the platform supports all required ISO 19650 functionalities (metadata, version control, audit logs, access control),
- Maintain access controls aligned with the information sensitivity and security protocols defined in Section 5 of this EIR,
- · Ensure that the platform logs:
 - o Uploads/downloads,
 - o Changes in status or suitability,
 - o Approvals and comments.

It is the responsibility of the appointed team to ensure models are submitted only to the CDE in the correct phase (e.g., Shared or Published), and that models comply with project naming and container requirements prior to submission

4.5. Access and Permissions

Only personnel authorized by their respective Task Team Managers may access the CDE. Access must be:

- · Role-based, with tiered permissions (e.g., Viewer, Contributor, Approver),
- Monitored, with all activity logged for auditability,
- · Managed through a documented CDE User Access Register.

All team members must receive training on using the CDE and its approval workflows as part of project onboarding.

5. SECURITY REQUIREMENTS

The Appointing Party shall apply the security-minded approach defined in ISO 19650-5:2020. A project-specific security triage process shall be conducted to determine the appropriate Security Tier (ST1 to ST3) based on the potential risks associated with unauthorized access to, or misuse of, project information.

- The outcome of the triage process shall be documented and communicated to all Appointed Parties.
- If the project is classified as ST2 or higher, a Built Asset Security Information Requirements (BASIR) document shall be prepared and shared as part of this EIR or as a separate annex.
- Appointed Parties must:
 - Comply with the security measures applicable to the assigned tier,
 - Implement appropriate controls in their information workflows and systems (e.g., access restriction, audit trails, encryption, personnel vetting where required),
 - o Confirm their approach in the BIM Execution Plan (BEP).

All security classifications, procedures, and responsibilities must be reviewed and updated at key project milestones or upon changes in project scope, threat level, or information sensitivity.

5.1. Security and Information Assurance

In accordance with ISO 19650-5 and relevant data protection regulations, the Appointed Parties must adopt a security-minded approach to all information management activities.

This includes the management of sensitive or classified information during the project lifecycle, both within the Common Data Environment (CDE) and across any information exchanges.

5.1.1. Baseline Requirements

- · All information systems must be secured against unauthorized access, tampering, or data loss.
- All project participants must apply access control policies and ensure that user roles and permissions
 within the CDE are maintained.
- Two-factor authentication is required for access to the CDE.
- · All data in transit must be encrypted using industry-standard protocols (e.g. HTTPS, SFTP).
- External file transfers must occur only via approved secure platforms.

5.1.2. Classification and Risk Assessment

The Appointing Party shall carry out a project-specific sensitivity and risk assessment in accordance with ISO 19650-5:2020 to determine the appropriate Security Tier (ST1 to ST3) for the information to be managed.

To support this, a Security Triage Checklist is provided as Appendix 4 to this EIR. This tool enables a structured evaluation of project risks (e.g., safety, operational disruption, confidentiality) and recommends a

corresponding tier based on a weighted scoring system. The completed checklist must be reviewed and signed off by the Appointing Party during project initiation.

Based on the outcome of this triage:

- If the project is classified as ST1, no formal security documentation is required beyond standard information management practices.
- · If the project is classified as ST2 or higher, the Appointing Party shall:
 - o Define and communicate the required security controls,
 - Provide or reference a Built Asset Security Information Requirements (BASIR) document, if applicable.
 - Ensure appropriate measures are taken to protect commercial, operational, or personal information, and establish an incident response procedure.

If at any stage during the project information is reclassified to a higher sensitivity level, all Appointed Parties shall be notified without delay and required to comply with the revised security protocols, including any updates to the BASIR or CDE access conditions.

5.1.2.1. Security Tier Determination Procedure

A Security Triage Checklist is provided as an external tool to support the Appointing Party in assessing the potential risks associated with the misuse, loss, or unauthorized access of project information. The checklist includes a series of structured questions aligned with ISO 19650-5:2020 and is designed to help determine the appropriate Security Tier (ST1–ST3) for the project. Each "Yes" response corresponds to a defined risk category and contributes to a weighted score, which is then mapped to a recommended tier level. The completed checklist and its outcome must be reviewed and approved by the Appointing Party during project initiation. The resulting Security Tier classification shall guide the security measures to be implemented across all information management processes and, where necessary, trigger the development of a Built Asset Security Information Requirements (BASIR) document.

5.1.2.2. Security Tier Definitions

Security Tiers are defined in alignment with ISO 19650-5:

Tier ST1 – Low Sensitivity

Minimal security requirements beyond standard confidentiality protocols. Appropriate for projects with no significant public safety, operational, or asset protection concerns.

• Tier ST2 - Medium Sensitivity

Moderate protective measures are required. Formal security procedures to be incorporated into the BEP. Appropriate where partial compromise could impact operations or public safety.

• Tier ST3 - High Sensitivity

Significant protective measures are required, including a formal Security Management Plan (SMP). Appropriate where compromise could severely impact public safety, national security, or critical infrastructure.

5.1.2.3. Security Tier Scoring Method

When applying the Security Triage Checklist (Appendix X), each identified **risk type** (as defined in 5.1.2.1) shall be assigned a numerical value according to its assessed severity:

- High Risk 3 points
- Moderate Risk 2 points
- Low Risk 1 point

The scores for all applicable risk types shall be summed to determine the overall **Security Tier** for the project:

Table 11 - Security Tier Scoring

Total Score	Security Tier	Description
0-3 points	ST1 – Low Sensitivity	Minimal security requirements beyond standard confidentiality protocols.
4–7 points	ST2 – Medium Sensitivity	Moderate protective measures required; formal security procedures incorporated into BEP.
8 points or more	ST3 – High Sensitivity	Significant protective measures required, including a formal Security Management Plan (SMP).

The calculated tier shall be documented in the BEP and approved by the Appointing Party before project commencement.

5.1.3. Supplier Responsibilities

All Appointed Parties must comply with the security requirements established by the Appointing Party based on the determined Security Tier. These responsibilities apply to the handling, sharing and protection of project information throughout its lifecycle and across all CDE environments.

Appointed Parties shall:

- Acknowledge and comply with the assigned Security Tier (ST1-ST3) as communicated by the Appointing Party,
- Implement appropriate access control mechanisms within their own systems and restrict information
 access to authorized personnel only,
- Ensure that all team members receive awareness training regarding the project's security protocols and associated risks,
- Apply security controls as defined in the Built Asset Security Information Requirements (BASIR), where required,

- · Participate in any security-related reviews, audits, or drills initiated by the Appointing Party,
- Immediately report any suspected security incidents or data breaches in accordance with the
 project's incident response procedure,
- Collaborate in the event of information reclassification by reviewing and updating access rights, workflows and relevant deliverables.

Failure to comply with agreed security responsibilities may result in restricted access to the Common Data Environment (CDE), temporary suspension of information workflows, or contractual penalties as applicable.

5.1.4. References

The following standards, legislation and guidance documents shall inform the security-minded approach to information management for this project:

- ISO 19650-5:2020 Organisation and digitization of information about buildings and civil
 engineering works, including building information modelling Part 5: Security-minded approach
 to information management
- PAS 1192-5:2015 (where referenced or used to supplement ISO 19650-5)
- Built Asset Security Information Requirements (BASIR) (if developed for this project based on the Security Tier outcome)
- · Appointing Party's internal Security Policy or Information Governance Guidelines (if supplied)
- · National or local data protection legislation, including:
 - o General Data Protection Regulation (GDPR), where applicable
 - Data Protection Acts specific to the country of delivery
- UK National Cyber Security Centre (NCSC) BIM Guidance (if applicable and adopted by the client organisation)

These references shall be reviewed at project initiation and revalidated if project scope, classification, or legal jurisdiction changes. The Appointing Party is responsible for making any required documentation available to Appointed Parties at the pre-contract stage or as soon as it becomes applicable.

6. BIM EXECUTION PLAN (BEP) RESPONSE

Appointed Parties must submit a pre-contract BEP as part of their tender submission. The BEP must:

- · Respond clause-by-clause to this EIR,
- · Include the Project Implementation Plan,
- · Define the MIDP and TIDPs,
- · Confirm roles, responsibilities and team capability,
- Outline quality control procedures, clash detection strategy and collaboration workflows.

The post-contract BEP must be agreed prior to project mobilisation and must be updated throughout the project.

The Lead Appointed Party shall ensure that all design coordination issues and QA observations are managed in a model-linked issue tracking platform such as Autodesk ACC Build, Revizto, or equivalent, in accordance with the project's CDE workflow.

6.1. QA/QC Workflow and Issue Tracking Methodology

The BEP shall describe in detail how the Appointed Party will meet the QA/QC and issue management requirements defined in Section 3.5 of this EIR. At a minimum, the BEP must include:

- · The chosen issue tracking platform(s) and how they will integrate with the project CDE,
- The workflow diagram showing the process from issue identification to closure, including approval stages and responsibilities,
- Frequency of QA/QC reviews and coordination meetings,
- Report formats for periodic issue summaries and final QA sign-off,
- · A description of how field inspections and on-site QA results will be reconciled with the model,
- A statement confirming that stage-gate approval of deliverables will be contingent upon closure of all critical issues.

Failure to include a satisfactory QA/QC workflow in the BEP may result in rejection of the BEP submission.

6.2. Performance Metrics and Reporting Requirements

To ensure consistent quality and compliance with the requirements of this EIR, all Appointed Parties shall report on defined Key Performance Indicators (KPIs) throughout the project lifecycle. These metrics shall be data-driven, drawn from project QA/QC processes, and updated in line with project milestones.

6.2.1. Measurement Scope

KPIs shall cover, at a minimum, the following areas:

· Issue Closure Rate:

- Percentage of open vs. closed issues at each stage-gate, as recorded in the approved issue tracking platform (e.g., Autodesk ACC Build, Revizto, BIMcollab).
- o Target: 95%+ of critical issues closed prior to stage-gate approval.

· Clash Density and Resolution:

- Number of unresolved clashes per building area (m²) before final coordination sign-off.
- Target: ≤ 0.1 unresolved clashes per 10 m² of GFA at coordination approval.

· Model Data Compliance:

- Percentage of required Level of Information Need (LOIN) fields populated in IFC or COBie datasets, verified by automated validation tools.
- o Target: 100% of mandatory COBie fields populated at handover.

· Validation Performance:

- Number of failed vs. passed automated checks (geometry, metadata, classification) at each coordination stage.
- Target: ≥ 90% pass rate before moving to "Published" in the CDE.

· Issue Resolution Time:

- o Average time taken to close assigned issues from creation to resolution.
- Target: ≤ 14 calendar days for critical issues, ≤ 30 days for non-critical issues.

6.2.2. Data Sources and Tools

- · All KPI data shall be extracted directly from:
 - o The project's approved issue tracking system,
 - o Model validation software,
 - o Power BI or equivalent dashboard reporting tools.
- Manual tracking in spreadsheets is permitted only where tool integration is not possible, and must be
 uploaded to the CDE in the agreed format.

6.2.3. Reporting Frequency

- · Design Phase: Monthly KPI updates or as defined in the BEP.
- Construction Phase: Bi-weekly updates for issue closure and clash counts.
- Handover: Final KPI report submitted with the Asset Information Model (AIM).

6.2.4. Integration with Stage-Gate Approvals · Stage-gate approval to progress from Shared to Published status in the CDE will only be granted if all KPI targets for that stage are met, or deviations are formally risk-assessed and approved by the Appointing Party. 24

7. BIM EXECUTION PLAN (BEP) RESPONSE

The purpose of this section is to ensure that structured and validated asset information is delivered at project closeout in accordance with ISO 19650-3 and BS EN ISO 19650-4, supporting the creation of a usable Asset Information Model (AIM). The AIM shall provide the Appointing Party with the data required for effective asset operation, maintenance and lifecycle management.

For complex projects, BESIX experience shows that successful AIM delivery requires alignment with actual FM integration workflows. Projects such as RTBF Media House and BNP Paribas Fortis have demonstrated the importance of:

- · Delivering full COBie datasets validated against BS 1192-4,
- Ensuring model element IDs match organizational asset import structures,
- Linking O&M documents directly to model elements for easy FM access.
 Where FM system integration is required, the project team shall carry out test imports into the target FM environment before handover to confirm compatibility.

7.1. Required Deliverables

The following asset-related deliverables must be provided prior to final handover, in accordance with the project's information requirements and agreed Level of Information Need (LOIN):

- IFC models, containing spatially and functionally accurate asset data aligned with the LOIN
 requirements and compliant with the object structures defined in linked IDS files (see Section 2.4
 and Shared Resources).
- Native design models (e.g., RVT, DWG, or other project-authoring formats), consistent with the federated and IFC models, to allow downstream stakeholders or facility managers to reuse or extract data where required.
- Structured asset data outputs, such as COBie spreadsheets or an equivalent format conforming to ISO 19650-4 and validated for completeness and integrity.
- Linked O&M documentation (e.g., commissioning records, test certificates, warranties, manuals), embedded in or referenced from the structured dataset, only when required by the client for asset operation purposes. If O&M use is not established as a client-side requirement, this deliverable may be excluded by agreement.
- · A comprehensive Data Validation Report summarizing:
 - o Validation checks performed (automated and/or manual),
 - o Status of each data package (RAG assessment),
 - Resolutions applied to flagged issues,
 - Date and sign-off from responsible parties.

The summary tables and documentation of technical systems form a key part of this dataset and must be consistent with model content and IDs. All deliverables must be coordinated with the project's CDE workflows and structured in accordance with the approval and metadata tagging protocols defined in this EIR.

7.2. Alignment with Modeling and Metadata Standards

All AIM-related data must be:

- Exported from discipline-specific models developed in compliance with IFC structuring rules set in Section 3.1.4 of this EIR,
- · Aligned with the object definitions and properties defined in the discipline-specific IDS files,
- Classified using Uniclass 2015, OmniClass, or a system agreed in the BEP and mapped to COBie. Type and Component sheets.

Naming conventions, spatial relationships, and metadata must be verifiable via automated tools prior to submission.

7.3. Asset Data QA Requirements

Prior to final handover, the Lead Appointed Party shall conduct an Asset Information QA review that includes:

- · Automated COBie validation to confirm 100% completion of mandatory fields,
- Verification that all asset data matches the agreed classification system and FM import schema,
- Spot-checking of model-linked documents (e.g., O&M manuals, warranties) to ensure they are
 present, current, and accessible,
- Producing an Asset Data Validation Report summarising compliance, outstanding issues, and corrective actions taken.
 - AIM acceptance by the Appointing Party is contingent upon successful completion of this QA review and, where applicable, a successful FM system import test.

7.4. Acceptance and Handover Protocol

To achieve contractual closure, the AIM must be:

- · Reviewed and accepted by the Appointing Party's Facility Management or Asset Information team,
- · Free of critical data gaps or validation failures,
- Delivered in formats compatible with the Appointing Party's organisational asset management system.

The final AIM submission shall be registered and archived in the CDE (Published State) and assigned an approval status (e.g., "Accepted", "Accepted with Comments", or "Rejected") in accordance with the project's CDE governance structure.

8. TRAINING AND COMPETENCY REQUIREMENTS

All Appointed Parties shall ensure that individuals involved in information production, coordination, review, and delivery possess the skills, knowledge, and experience appropriate to their roles and responsibilities as defined in the BEP and in accordance with ISO 19650-2 Clause 5.4.4.

This includes proficiency in:

- · BIM methodologies and collaborative workflows,
- CDE platforms and model validation tools,
- Relevant international and project-specific standards (e.g., ISO 19650 series, IFC schema, COBie data structure).

8.1. Competency Evidence

Each Appointed Party shall submit documentation confirming their team's capability. Acceptable forms of evidence include (but are not limited to):

- · Completion of recognized training courses (e.g., ISO 19650 awareness, BIM coordination),
- Valid BIM certifications for organisations and/or individuals (e.g., BSI BIM Level 2, ISO 19650-2 Lead Appointed Party),

References from previous BIM-enabled projects of similar complexity,

- CVs or role profiles for nominated BIM roles (e.g., Task Team Information Manager, Model Author),
- · Demonstration of internal quality assurance processes for information delivery.

8.2. Training Responsibilities

The Information Manager of the Lead Appointed Party is responsible for:

- · Outlining a training and competency strategy in the BEP,
- Identifying any role-specific skill gaps and recommending supplementary training,
- · Ensuring all project participants receive adequate onboarding for:
 - CDE workflows and permissions,
 - File naming and metadata conventions,
 - o Issue management and model coordination platforms.

8.3. Appointing Party Requirements

Where the Appointing Party deems it necessary (e.g., due to complexity, sensitivity, or regulatory requirements), additional training may be mandated. This may include:

•	Project-specific onboarding sessions,
•	Periodic audits of training records or competency declarations.
	ining and onboarding activities must be completed prior to the first information exchange and updated
role	s or tools evolve.

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APPENDIX 2: PROPOSED FILLABLE EIR TEMPLATE

1. INTRODUCTION

This Exchange Information Requirements (EIR) form is designed to clearly set out the information the client (Appointing Party) needs at different stages of the project. It follows the ISO 19650 framework but has been simplified into a practical, fillable format so that it can be completed quickly and consistently.

The document is divided into sections that cover project details, timelines, required deliverables, roles and responsibilities, information exchange processes, security considerations, and performance tracking. Each table is accompanied by a short description to explain its aim and guide you in providing the right information.

Each section of this fillable EIR template begins with a sample table (grey shaded) showing example entries. These examples illustrate the type and level of detail expected and should not be altered — they are for guidance only. Following each sample, you will find blank tables for entering your own project-specific information. Some sections also include informative tables (green shaded) which explain relevant standards, concepts, or processes; these are for reference and should be read before completing the related fields.

Colour Legend:

- Grey Table Example only; shows what kind of information is required.
- White Table Blank fields for you to complete with project-related data.
- Green Table Informative content explaining standards, concepts, or workflows; not to be filled in.

To use this document:

- 1. Read the guidance before each table to understand what type of information is required.
- Fill in all relevant fields as accurately as possible, using official project documents, contracts, schedules, and agreed workflows as your source.
- Coordinate with other project team members to ensure the information is correct, complete, and consistent with the BIM Execution Plan (BEP) and other project records.
- Keep the document up to date throughout the project lifecycle. Some sections, such as KPIs, training logs etc., will need to be reviewed and updated regularly.

The completed EIR will form part of the project's contractual information requirements. It will be used to guide the preparation of the BEP, to plan and check information exchanges, and to ensure that the final Asset Information Model (AIM) meets the client's operational needs.

2. INFORMATION REQUIREMENTS

2.1. Project Overview

Table 1 captures the basic details of the project. Use official contract or tender documents to fill in project name, code, client, and key parties. The "Lead Appointed Party" is usually the main contractor or design team responsible for delivering BIM requirements. The date of issue is when this EIR form is released for the project.

Table 1 - Project Overview Table

Field	Input
Project Name	
Project Type	
Project Code	
Project Description	
Client / Appointing Party	
Lead Appointed Party	
Contract Type	
Contract Reference	
Date of Issue	Select the date.

2.2. Key Project Dates & Stages (RIBA Plan of Work)

Table 2 lists the recognised RIBA Plan of Work stages in sequence, providing their official names and brief descriptions so that all project participants have a shared understanding of each phase and can align activities, deliverables, and timelines accordingly.

Table 2 – RIBA Project Stages

RIBA Stage	Official RIBA Name	Notes
Stage 0	Strategic Definition	Strategic project outcomes defined, business case prepared.
Stage 1	Preparation and Briefing	Project brief developed, feasibility confirmed.
Stage 2	Concept Design	Concept design prepared according to the project brief.
Stage 3	Spatial Coordination	Design coordinated between disciplines and aligned to spatial constraints.
Stage 4	Technical Design	All design details finalised and suitable for manufacturing/construction.
Stage 5	Manufacturing and Construction	Construction or manufacturing of building elements.
Stage 6	Handover	Completion, commissioning, and handover of the asset to operations.
Stage 7	Use	Post-occupancy evaluation, in-use monitoring, and ongoing asset management to ensure performance meets operational needs.

Table 3 sets the timeline for each stage of the project according to the RIBA Plan of Work. For each stage, write the planned start and end dates and any important notes (e.g., special approvals or milestones). Use the programme agreed with the client or project manager to ensure dates match the official schedule.

Table 3 - Key Project Dates

Stage	Start Date	End Date	Notes
0 – Strategic Definition	Select the date.	Select the date.	
1 – Preparation & Briefing	Select the date.	Select the date.	
2 – Concept Design	Select the date.	Select the date.	
3 – Spatial Coordination	Select the date.	Select the date.	
4 – Technical Design	Select the date.	Select the date.	
5 - Manufacturing & Construction	Select the date.	Select the date.	
6 – Handover	Select the date.	Select the date.	
7 – Use	Select the date.	Select the date.	

2.3. Information Requirements Summary

2.3.1. Organisational Information Requirements (OIR)

Table 5 links the client's strategic goals to the specific types of information the project must deliver. Mark the applicable goals, and for each OIR category, determine the required information, identify its typical sources (e.g., contracts, reports, schedules), and assign a priority level. Use the client's asset strategy, sustainability targets, and operational requirements to guide your inputs.

Key strategic goals for this project:
☐ Space Utilisation
☐ Asset Lifecycle Costing
☐ Maintenance & FM
☐ Regulatory Compliance
☐ Carbon & Energy Compliance
☐ Risk and Security
□Other

Table 4 - Organisational Information Requirements - Example Only - Not Project Data

OIR Category	Requirement	Typical Source	Priority
Space Utilisation	Maintain a minimum 85% occupancy efficiency in all office areas to support the corporate workplace strategy.	Architectural model, space occupancy reports	High
Asset Lifecycle Costing	Provide a 30-year CAPEX/OPEX model for major systems, including replacement schedules and energy costs.	Cost plans, FM data, COBie dataset	High
Maintenance & FM	All mechanical systems must include asset IDs, maintenance intervals, and warranty data in COBie format.	Manufacturer datasheets, O&M manuals	High
Regulatory Compliance	Provide certification evidence for fire safety, accessibility, and energy performance compliance.	Compliance reports, inspection certificates	Medium
Carbon & Energy Performance	Achieve ≤ 65 kWh/m ² annual energy use and document carbon emissions for main building systems.	Sustainability assessments, energy model output	Medium
Risk and Security	Provide zoning diagrams for restricted access areas and integrate with the site-wide access control system.	Risk assessment, security design layouts	Medium

Table 5 - Organisational Information Requirements

OIR Category	Requirements	Typical Source	Priority
Space Utilisation			Choose an item.
Asset Lifecycle Costing			Choose an item.
Maintenance & FM		1	Choose an item.
Regulatory Compliance			Choose an item.
Carbon & Energy Performance			Choose an item.
Risk and Security			Choose an item.

2.3.2. Project Information Requirements (PIR) - Plain Language Questions

Table 7 lists the key project questions that must be answered at certain stages to help the client make decisions. Write each question in clear, everyday language (e.g., "Are all fire safety requirements met?"). Link it to the relevant RIBA stage, describe the deliverables needed to answer it (e.g., drawings, reports), specify the required file format(s), assign the discipline responsible, and reference any related EIR clauses.

Table 6 - Project Information Requirements - Example Only - Not Project Data

PLQ Ref	PLQ	Stage	Required Info	Format	Discipline
PLQ01	Can the site strategy accommodate the functional program?	Stage 2 – Concept Design	Site layout, zoning plan, parking analysis	PDF, DWG, IFC	Architecture
PLQ02	Is the proposed structural scheme compatible with architectural intent?	Stage 3 – Spatial Coordination	Structural grid, structural model with coordination zones	IFC, PDF	Structure
PLQ03	Have all statutory compliance criteria been met?	Stage 4 – Technical Design	Fire strategy, access & egress models, code check reports	PDF, BCF, XLSX	Multidisciplinary
PLQ04	Are the building services spatially coordinated and energy targets met?	Stage 4 – Technical Design	MEP coordination model, energy model summary	IFC, XLSX	MEP
PLQ05	Can FM systems be populated at handover?	Stage 6 – Handover	Asset register, COBie dataset, O&M manuals	COBie, PDF	All disciplines

Table 7 - Project Information Requirements

PLQ Ref	PLQ	Stage	Required Info	Format	Discipline	Linked EIR Ref
		Choose an item.		Choose an item.	Choose an item.	Choose an item.
		Choose an item.		Choose an item.	Choose an item.	Choose an item.
		Choose an item.		Choose an item.	Choose an item.	Choose an item.
		Choose an item.		Choose an item.	Choose an item.	Choose an item.
		Choose an item.		Choose an item.	Choose an item.	Choose an item.

2.3.2.1. Chec	:klist – Proi	ect Information	Requirements	MIR – F	PLOs)
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\square Every PLQ is clearly written and easy to understand (no technical jargon without explanation).
☐ Each PLQ is linked to a specific RIBA stage.
☐ Required deliverables and file formats are listed for each PLQ.
\square A responsible discipline is assigned to each PLQ.
\square All PLQs have been cross-checked with the client's brief and statutory requirements.

б

2.3.3. Asset Information Requirements (AIR)

Table 8 defines the data and documents that must be provided at handover for the client to run and maintain the asset. For each asset category (spaces, systems, documents, etc.), list the specific data to be provided (e.g., room names, equipment IDs, maintenance schedules), the target format (e.g., IFC, COBie, PDF), and how the data will be checked for accuracy (e.g., validation tool, manual review).

Table 8 - Project Information Requirements - Example Only - Not Project Data

Asset Category	Key Data Required	Target Format	Validation Method
Spaces & Zones	Room name, unique room ID, usage type, floor area (GIA/NIA), occupancy capacity	IFC 4.3 + COBie.Space	IFC spatial hierarchy check + automated LOIN validation
Systems & Equipment	Equipment ID, type description, manufacturer, model number, location, warranty expiry date, maintenance interval	COBie.Component + IFC	COBie validator + visual check in federated model
Documentation	As-built drawings, commissioning certificates, test results, O&M manuals	PDF linked in COBie	Document completeness review against the deliverables list
Energy Performance	System energy rating, annual energy consumption estimate and carbon footprint data	COBie.Type + XLSX	Data template check + comparison with energy model
Maintenance	Maintenance task description, frequency, responsible team/contractor, first service date	COBie.Job	FM system import test + QA log review

Table 9 - Asset Information Requirements

Asset Category	Key Data Required	Target Format	Validation Method
Spaces & Zones			
Systems & Equipment			
Documentation			
Energy Performance			
Maintenance			

2.3.3.1. The Level of Information Need Data Collection

The Level of Information Need (LOIN) for each deliverable shall be defined using the LOIN Data Collection Form embedded within this fillable EIR template. The form is included as an integrated Excel spreadsheet, accessible from this section, to allow direct entry of the required data in a structured format. It must be completed by the Lead Appointed Party, in collaboration with relevant Task Teams, and submitted to the Appointing Party as part of the pre-contract BEP submission. The form shall be maintained as a live document throughout the project lifecycle, ensuring that all LOIN requirements remain current and aligned with the Asset Information Requirements (AIR).



2.3.3.2. Checklist - Asset Information Requirements (AIR)

☐ All asset categories relevant to the project are listed.
□Key data fields for each category are complete.
□Formats match the client's FM system requirements.
\square Validation methods are clearly stated.
\square AIR aligns with the OIR and PIR.
☐ The LOIN Data Collection Form has been completed for all applicable deliverables.
\square LOIN requirements in the form match the AIR table and project scope.
\Box The LOIN Data Collection Form has been submitted to and approved by the Appointing Party.

3. MANAGEMENT / STANDARDS / ROLES

3.1. Roles Scaling and Resource Adaptation

Table 10 explains how BIM-oriented roles will be covered based on the project's size and available resources. Choose the row that best matches your project team (large, medium, or small) and, if needed, describe any combined or adapted roles. Confirm this with the BIM Manager so that no responsibility is left unclear.

Table 10 - Role Scaling

Team Size	Typical Role Coverage	Notes
Large	Full ISO 19650 role structure: Appointing Party Information Manager, Lead Appointed Party Information Manager, Task Team Managers, QA Lead, CDE Administrator, Model Authors	Clear separation of authoring, QA, and coordination tasks
Medium	Some roles combined (e.g., Task Team Manager doubles as QA Lead)	Role combinations must be documented in BEP RAM
Small	Multiple roles merged (e.g., one BIM Coordinator handles authoring, QA, and CDE admin)	Higher risk of conflict of interest, QA review should be carried out by another project team where possible

3.1.1. Determining Project Team Size

For the purposes of this EIR, project team sizes are classified as **Small**, **Medium**, or **Large**. The classification shall be determined by the Appointing Party during project mobilisation and documented in the BEP. The assessment shall be based on the criteria described in the following table.

Table 11 – Team Size Criteria

Criteria	Small Team	Medium Team	Large Team
Project Value	<€10 million	€10–50 million	>€50 million
Disciplines Involved	≤3 disciplines	4–6 disciplines	> 6 disciplines
BIM Requirements	Basic modelling, minimal coordination	Federated model with coordination	High LOIN, multiple exchanges, advanced QA/QC
Stakeholders	≤5 organisations	6-10 organisations	> 10 organisations
Project Duration	< 12 months	12–24 months	> 24 months

3.2. Roles & Responsibilities (RAM - RACI Model)

Tables 12 and 13 map who will be responsible for what for each BIM deliverable or task. Mark each cell with R (Responsible), A (Accountable), C (Consulted), or I (Informed) for each role. Use the BEP or project organisation chart to make sure assignments are accurate and agreed with all parties.

Table 12 - RAM (Large Team) - Example Only - Not Project Data

Deliverable / Task	Appointing Party	Lead Appointed Party	Task Team Manager	Information Manager	Discipline Author
Define EIR	R	С	•	-	-
Develop Pre-Contract BEP	С	R	A	A	-
Submit TIDP	-	С	R	A	-
Validate IFC export	-	A	С	R	R
Perform Clash Detection	-	R	A	С	С
Submit COBie at Handover	-	A	С	R	R

Table 13 – RAM (Large Team)

Deliverable / Task	Appointing Party	Lead Appointed Party	Task Team Manager	Information Manager	Discipline Author
Define EIR.	Please select.	Please select.	Please select.	Please select.	Please select.
Develop BEP	Please select.	Please select.	Please select.	Please select.	Please select.
Submit TIDP	Please select.	Please select.	Please select.	Please select.	Please select.
Validate IFC Export	Please select.	Please select.	Please select.	Please select.	Please select.
Perform Clash Detection	Please select.	Please select.	Please select.	Please select.	Please select.
Submit COBie at Handover	Please select.	Please select.	Please select.	Please select.	Please select.

Table 14 - RAM (Medium Team)

Deliverable / Task	Appointing Party	Lead Appointed Party	Information Manager	Task Team Manager / Discipline Author
Define EIR	Please select.	Please select.	Please select.	Please select.
Develop BEP	Please select.	Please select.	Please select.	Please select.
Submit TIDP	Please select.	Please select.	Please select.	Please select.
Validate IFC Export	Please select.	Please select.	Please select.	Please select.
Perform Clash Detection	Please select.	Please select.	Please select.	Please select.
Submit COBie at Handover	Please select.	Please select.	Please select.	Please select.

Table 15 - RAM (Small Team)

Deliverable / Task	Appointing Party	Lead Appointed Party / Information Manager	Discipline Author (incl. Task Team Manager)
Define EIR	Please select.	Please select.	Please select.
Develop BEP	Please select.	Please select.	Please select.
Submit TIDP	Please select.	Please select.	Please select.
Validate IFC Export	Please select.	Please select.	Please select.
Perform Clash Detection	Please select.	Please select.	Please select.
Submit COBie at Handover	Please select.	Please select.	Please select.

3.2.1.1. Checklist - Roles & Responsibilities (RAM)

$\label{eq:constitution} \square \text{Every listed task has a RAM value (Responsible, Accountable, Consulted, Informed)}.$
\square Assignments match the BEP and project organisation chart.
\square Any combined or adapted roles are documented.
☐Discipline leads have confirmed their responsibilities.

4. COMMON DATA ENVIRONMENT (CDE)

Table 15 captures the agreed platform(s) and rules for managing digital project information. Fill in the name of the CDE platform(s), describe the internal and client-side workflows, reference the naming convention standard, and define the access permission for each role. Use the BEP and CDE setup documents as your source.

Table 16 - Common Data Environment Details - Example Only - Not Project Data

Requirement	Project Details
CDE Platform(s)	Internal: Autodesk ACC Build (BESIX license) for design coordination. Client CDE: Aconex for contractual document and model delivery.
Internal CDE Workflow summary	Design teams upload WIP models weekly to ACC "Work in Progress" folder. Once internal QA is complete, files move to "Shared" for coordination.
Client CDE Workflow summary	Only approved "Published" models and documents from ACC are uploaded to Aconex for client review and final acceptance.
Naming convention reference	ISO 19650 naming convention: ProjectCode-Originator-Discipline-DocumentType-Zone-Number- Revision. Example: BRA01-BES-ARC-MOD-00A-0001-S1-P01
Access permissions & roles	ACC: Task Team Leads – Edit, BIM Manager – Approve, <u>All</u> other team members – View only. Aconex: Client's document control team – Full admin rights.

Table 17 - Common Data Environment Details

Requirement	Project Details
CDE Platform(s)	
Internal CDE Workflow summary	
Client CDE Workflow summary	
Naming convention reference	
Access permissions & roles	

4.1.1.1. Checklist - Common Data Environment (CDE)

\square Chosen CDE platform(s) are confirmed with all parties.
☐Internal and client workflows are described.
□Naming conventions are documented and accessible.
□Permissions and access roles are assigned.
\square Test upload/download performed to confirm workflows.
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5. SECURITY REQUIREMENTS

5.1. Security Triage Checklist

Table 16 helps you assess whether the project contains sensitive information or systems. For each question, answer "Yes" or "No" and provide notes if the answer is "Yes". Use the project scope, design information, and client requirements to make informed answers.

Table 18 - Security Tier Decision Checklist

Ref	Question	Response (Y/N)	Notes / Details
STQ1	Will the asset contain sensitive operational systems (e.g.,	Choose an	
SiQi	security, surveillance, IT infrastructure)?	item.	
STQ2	Could a compromise of the project's information result in a	Choose an	
31Q2	significant public safety risk?	item.	
STQ3	Will the project involve the storage or processing of personal	Choose an	
51Q5	or confidential data?	item.	
STQ4	Does the project involve restricted areas or controlled access	Choose an	
510+	zones?	item.	
STQ5	Could disclosure of asset layouts, systems, or security	Choose an	
3103	measures aid in unlawful activity?	item.	
STQ6	Is the project subject to defence, emergency services, or	Choose an	
3100	national security regulation? item.		
STQ7	Will project stakeholders need to comply with specific	Choose an	
510,	governmental or client-imposed security clearances?	item.	
STQ8	Are there known or anticipated threats specific to the project	Choose an	
5100	location or asset type?	item.	

5.2. Security Tier Scoring

Table 17 records the result of your security risk assessment. Enter the total score from the Security Triage Checklist and the matching tier (ST1, ST2, or ST3) along with its description. This will guide the security measures applied to project information.

Table 19 - Security Tier Scoring Logic

Total Score	Security Tier	Description
0-3 points	ST1 – Low Sensitivity	Minimal security requirements beyond standard confidentiality protocols.
4-7 points	ST2 – Medium	Moderate protective measures required; formal security procedures incorporated into
4-7 points	Sensitivity	BEP.
8 points or more	ST3 - High Sensitivity	Significant protective measures are required, including a formal Security Management
o points of more	515 - Ingil Selisitivity	Plan (SMP).

Security Triage Checklist is fully completed. The correct security tier (ST1, ST2, ST3) is assigned. Any required BASIR documents are prepared. Security measures are included in the BEP. All relevant team members have been briefed on security rules.		
□ The correct security tier (ST1, ST2, ST3) is assigned. □ Any required BASIR documents are prepared. □ Security measures are included in the BEP. □ All relevant team members have been briefed on security rules.	5.2.1.1. Checklist - Security Requirements	
□Any required BASIR documents are prepared. □Security measures are included in the BEP. □All relevant team members have been briefed on security rules.	☐ Security Triage Checklist is fully completed.	
□Security measures are included in the BEP. □All relevant team members have been briefed on security rules.	\Box The correct security tier (ST1, ST2, ST3) is assigned.	
□All relevant team members have been briefed on security rules.	☐ Any required BASIR documents are prepared.	
	☐ Security measures are included in the BEP.	
14	☐ All relevant team members have been briefed on security ru	ies.
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6. BIM EXECUTION PLAN (BEP) RESPONSE

6.1. BEP Response Checklist (to be provided by Lead Appointed Party)

The list below is used to check whether the Lead Appointed Party's BIM Execution Plan (BEP) covers all EIR requirements before the process starts. Mark each box only when the BEP has that item clearly addressed and approved.

☐ Pre-contract BEP submitted with tender
☐ Post-contract BEP agreed before mobilisation
☐ Mobilisation plan is included
☐ MIDP & TIDPs included
☐ QA/QC process defined
☐ Issue tracking integrated with CDE
☐ KPIs agreed

6.2. KPI Tracking (during project)

Table 19 monitors how well the project is meeting the agreed BIM performance targets. For each KPI, define it, set a target value, record actual performance, note the variance, give a RAG status (Red, Amber, Green), and name the data source/tool and the responsible person. Update this regularly using project reports or dashboards.

Table 20 - KPI Tracking - Example Only - Not Project Data

Reporting Period	KPI Name	Definition	Target Value	Actual Value	Variance (%)	Status (RAG)	Data Source / Tool	Responsible Party	Notes / Corrective Actions
Week 32, 2025	Clash Detection Pass Rate	Percentage of federated model tests passing without critical clashes	≥ 95%	92%	-3%	Amber	Navisworks / Solibri	BIM Coordinator	Minor MEP-to- Structure clashes remain to be resolved by 12/08/2025.
Week 32, 2025	Issue Resolution Time	Average time to resolve QA/QC issues from logging to closure	≤ 10 days	8 days	+20%	Green	Autodesk ACC Build	QA Lead	Resolution time within limits; monitor to maintain performance.
Week 32, 2025	COBie Completeness	Percentage of required COBie fields populated and valid	100%	96%	-4%	Amber	COBie Validator / Power BI	Information Manager	Missing warranty dates for HVAC assets; follow up with the supplier.
Week 32, 2025	Stage-Gate Compliance	Percentage of deliverables approved on first submission at each stage-gate	≥90%	85%	-5%	Red	CDE Approval Logs	Lead Appointed Party	Additional QA checks to be enforced before submissions.

Table 21 - KPI Tracking

Reporting Period	KPI Name	Definition	Target Value	Actual Value	Variance (%)	Status (RAG)	Data Source / Tool	Responsible Party	Notes / Corrective Actions
Select a date.						Select			
Select a date.						Select			
Select a date.						Select			
Select a date.						Select			

7. TRAINING AND COMPETENCY REQUIREMENTS

Table 21 logs the BIM skills and training of each team member involved in information management. Record the person's name, organisation, role, certifications, ISO 19650 training status, other training, date of last training, competency level, who assessed it, and any actions needed. Use HR training records, CVs, and certificates to complete this.

Table 22 - Training and Competency - Example Only - Not Project Data

Name	Organisation	Role on Project	BIM Certification	ISO 19650 Training (Y/N)	Other Relevant Training	Date of Last Training	Compe tency Level (1–5)	Assessed By	Notes / Actions Required
Jane Smith	BESIX	Lead Appointed Party Information Manager	buildingSMAR T Professional Certification – Foundation	Y	Autodesk ACC Build Coordination	15/05/25	5	Project Director	Maintain certification renewal in 2027.
Mark Vries	BESIX	BIM Coordinator (Structure)	Solibri Model Checker – Advanced	Y	Navisworks Manage Clash Detection	10/06/25	4	BIM Manager	Refresher course on IFC 4.3 export planned Q4 2025.
Sofia Fernand es	MEP Subcontractor	Discipline Author (MEP)	None	N	Revit MEP Essentials	22/03/24	3	QA Lead	Needs ISO 19650 training before Stage 3.
Ahmed Khan	BESIX	QA/QC Lead	None	Y	Onsite QA/QC Inspection Workflow	05/07/25	4	Appointing Party IM	Consider BIM-related certification in 2026.
Laura Chen	BESIX	CDE Administrator	None	Y	CDE Workflow Administration	18/01/25	4	Information Manager	No immediate action required.

Table 23 - Training and Competency

Name	Organisation	Role on Project	BIM Certification	ISO 19650 Training (Y/N)	Other Relevant Training	Date of Last Training	Compe tency Level (1-5)	Assessed By	Notes / Actions Required
				Choose an item.			Select		
				Choose an item.			Select		
				Choose an item.			Select		
				Choose an item.			Select		

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym Full Form / Description

AIM Asset Information Model - a structured, validated set of information

required for operating and maintaining an asset.

AIR Asset Information Requirements - the data and information the client

needs about an asset to manage it effectively.

BCF BIM Collaboration Format – an open format for sharing issue tracking

information linked to model elements.

BEP BIM Execution Plan - a document outlining how BIM will be

implemented, managed, and delivered on a project.

BESIX Group - the construction and real estate company.

BIM Building Information Modelling - the process of creating and managing

digital representations of physical and functional characteristics of a

facility.

CAPEX Capital Expenditure - costs incurred to acquire, upgrade, or maintain

physical assets.

CDE Common Data Environment - the centralised platform for storing, sharing,

and managing project information.

COBie Construction Operations Building Information Exchange - a standard data

format for delivering asset data.

DWG Drawing file format (AutoCAD) - a common CAD drawing format.

EIR Exchange Information Requirements - the client's specification of the

information they require from the project team.

FM Facilities Management - the management of building services and assets

to support the organisation's needs.

GIA Gross Internal Area – the total floor area inside the building envelope.

HVAC Heating, Ventilation, and Air Conditioning – building systems that regulate

indoor climate.

IFC Industry Foundation Classes - an open standard data format for exchanging

BIM data.

ISO International Organization for Standardization - an independent, non-

governmental international standards body.

KPI Key Performance Indicator - a measurable value that demonstrates how

effectively objectives are being met.

LOIN Level of Information Need - a standard for defining the amount and detail

of information required.

MEP Mechanical, Electrical, and Plumbing – the building systems for services.

MIDP Master Information Delivery Plan – a plan detailing when project

information will be delivered, by whom, and in what format.

NIA Net Internal Area – the usable floor area within a building.

OIR Organisational Information Requirements - the high-level business

information needs of the client organisation.

O&M	Operations and Maintenance – documentation and activities related to running and maintaining an asset.
PIR	Project Information Requirements – the information needed at key stages of a project to support decisions.
PLQ	Plain Language Question – a non-technical question defining the purpose of information to be delivered.
QA	Quality Assurance – processes ensuring deliverables meet quality standards.
QC	Quality Control - checks performed to verify the quality of deliverables.
RACI	Responsible, Accountable, Consulted, Informed – a responsibility assignment model.
RAG	Red, Amber, Green – a traffic-light style status indicator for performance or progress.
RAM	Responsibility Assignment Matrix - a table assigning roles and responsibilities.
RIBA	Royal Institute of British Architects – a professional body with the Plan of Work framework for building projects.
ST1 / ST2 / ST3	Security Tier 1 / 2 / 3 - classification of project sensitivity based on risk assessment.
TIDP	Task Information Delivery Plan - a plan detailing the information to be
	delivered by a specific task team.
WIP	Work in Progress - information or models still under development, not yet
	approved for sharing.
XLSX	Microsoft Excel Open XML Spreadsheet format.

APPENDIX 3: DEVELOPED IDS FILE

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