Towards Submission-Stage Validation in BIM-to-Cadastre Workflows: Assessing IDS 1.0 for 3D Condominium Registration in Morocco

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Abstract

BIM models submitted for three-dimensional condominium cadastral workflows must satisfy a minimum set of conditions before they can support downstream transformation and legal registration. Using a Moroccan condominium case study, this paper investigates how far Information Delivery Specification (IDS) 1.0 can support submission-stage admissibility checking. The analysis distinguishes four types of admissibility requirements: structural-semantic, relational, arithmetic, and geometric-external. IDS supports declarative structural-semantic checks directly. Relation-based checks are partially supported, and arithmetic and geometry-dependent conditions remain outside executable IDS 1.0 support. To examine this boundary empirically, an IDS-based validation set was derived from Moroccan condominium admissibility requirements and executed on an enriched IFC model of a residential building in Rabat. The results show that IDS is effective for structured metadata and selected relation checks, while arithmetic consistency, geometric validity, and the completeness of legally relevant spaces remain outside executable IDS 1.0 support. IDS is therefore best understood as a first-layer admissibility mechanism within a broader cadastral validation pipeline. Its practical value lies in providing standardized, machine-readable validation that can be executed automatically. Complementary methods, however, remain necessary for quantitative consistency, geometric validation, completeness assessment, and external institutional verification.

1. Introduction

Three-dimensional cadastral registration is necessary to represent property situations in multi-level and subdivided buildings, where two-dimensional cadastral approaches are often insufficient to describe legal spaces, condominium units, and volumetric rights (Oldfield et al., 2017). In the context of condominiums, the process of registration demands more than identifying physical spaces: it requires a precise delineation of private areas, common spaces, ownership units, and legal volumes related to restrictions (Kalogianni et al., 2020). Building Information Models (BIM), and more specifically the Industry Foundation Classes (IFC), are increasingly used as a source of spatial and semantic information for such objectives (Oldfield et al., 2017; Petronijević et al., 2021; Stoter et al., 2024).

IFC cannot be reused directly in 3D cadastral workflows without further qualification and validation (Petronijević et al., 2021; Broekhuizen et al., 2025). Architectural BIM models are generally not produced for cadastral registration, and their use in legal-administrative processes requires further preparation. The mismatch extends beyond geometry: architectural BIM represents the physical and functional structure of buildings, whereas cadastral systems must represent legally defined spaces, boundaries, rights, and restrictions (Oldfield et al., 2017; Atazadeh et al., 2017). It is also procedural because cadastral agencies expect controlled submission workflows, not raw design exports (Oldfield et al., 2018; Stoter et al., 2024). Real BIM submissions may lack sufficiently structured IfcSpace entities, consistent georeferencing, and legal-semantic attributes required for cadastral processing (Broekhuizen et al., 2025). Pre-validation is therefore a necessary step before any downstream transformation into a land administration environment.

On the openBIM side, the buildingSMART community developed the Information Delivery Specification (IDS) as a machine-readable standard for defining information requirements and checking whether IFC models comply with them (buildingSMART International, 2024). IDS has been used in digital building permit and other submission-oriented workflows because it supports structured validation of entities, property sets, mandatory attributes, and allowed values (buildingSMART International, 2024; Fischer et al., 2025). Its expressive scope is better suited to declarative information requirements than to advanced geometric, arithmetic, or deeper logical reasoning (Fischer et al., 2025). Requirements involving cross-element computation or geometric reasoning may therefore require complementary rule-checking approaches. These may include external computational procedures or frameworks that combine IDS-based information checking with calculation or geometric collision-checking capabilities (Nuyts et al., 2024; Cerovšek and Omar, 2024; Heiß et al., 2025).

This raises the following research question: to what extent can IDS support submission-stage admissibility checking of BIM models intended for 3D condominium cadastral workflows? In condominium registration, some admissibility conditions are readily expressible in IDS, including the presence of mandatory property sets, legal identifiers, ownership metadata, and controlled values. Others are more demanding. These include grouping relations between spaces and legal units, arithmetic consistency of co-ownership shares, and geometric non-overlap of legal volumes. Existing cadastral studies have addressed BIM/IFC information requirements, legal-space modelling, and registration workflows (Oldfield et al., 2018; Stoter et al., 2024), whereas IDS research has focused on general BIM information delivery and automated compliance checking (Fischer et al., 2025; Cerovšek and Omar, 2024). The use of IDS specifically for submission-stage cadastral admissibility therefore remains underexplored.

This paper examines IDS as a submission-stage admissibility mechanism for BIM submissions intended for 3D cadastral registration. Using the Moroccan condominium context, the study derives admissibility requirements, translates the IDS-compatible subset into executable checks, and evaluates the

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resulting validation behaviour on an enriched IFC model of a residential condominium building.

The study makes three contributions. It proposes a four-type analytical decomposition of cadastral admissibility requirements according to the kind of evidence they require. It analyses the validation coverage of IDS 1.0 across these types and identifies the practical boundary between directly supported, bounded, and unsupported cases. Finally, through an enriched IFC case study and controlled model variants, it examines how this boundary appears in practice and where complementary mechanisms remain necessary.

2. Background

2.1 Information Requirement Frameworks in BIM-to-cadastre Workflows

The question of what information a BIM model must contain before entering a cadastral workflow has been an explicit concern in the BIM-to-cadastre research. The transition from building design models to the formal cadastral registration depends not only on geometric conversion, but also on a clear specification of what information must be delivered, by whom, at which stage, and for which downstream use. Oldfield et al. (2018) proposed an Information Delivery Manual (IDM) for the 3D cadastral lifecycle, framing cadastral information exchange as a process and delivery problem rather than only a modelling one.

Oldfield et al. (2017) argued that open BIM standards can source legal spaces for a 3D cadastre, while noting that the challenge lies in identifying the relevant BIM subset rather than reusing IFC wholesale. Their approach combined IDM process modelling with a Model View Definition (MVD) to translate cadastral exchange requirements into a relevant technical subset of IFC. More recently, Stoter et al. (2024) developed the BIM Legal approach for cadastral registration of apartment complexes in 3D and identified information delivery requirements and pre-registration quality checks as open questions. Broekhuizen et al. (2025) subsequently examined the technical validation of real-world IFC models, including the availability of IfcSpace, georeferencing, geometric validity, and overlap conditions.

2.2 IDS in openBIM Workflows

The openBIM community has developed IDS as a machine-readable standard for defining information requirements and checking whether an IFC model satisfies them. IDS expresses exchange requirements in a structured XML format so that software tools can automatically validate IFC content against predefined expectations. Its core strength lies in declarative checking of entities, property sets, mandatory attributes, and allowed values (buildingSMART International, 2024). Each IDS file contains a set of specifications. For each specification, the applicability section identifies the target IFC entities, while the requirements section defines what those entities must contain. These constraints are expressed through six facets: entity, attribute, property, classification, material, and partOf relationship (buildingSMART International, 2024).

IDS has been applied in building-permit and other compliance-oriented delivery workflows. Fischer et al. (2025) show how IDS bridges the gap between tabular information requirements and machine-executable constraints, while Cerovšek and Omar (2024) provide a broader analysis of advancements and remaining gaps in IDS-based compliance checking. IDS is strongest for explicit alphanumeric requirements, whereas relational semantics, derived values, cross-instance calculations, and geometry-dependent conditions may require complementary mechanisms (Nuyts et al., 2024; Cerovšek and Omar, 2024). These limitations are reflected in recent efforts to extend IDS-based checking with calculation and geometric collision-checking capabilities (Heiß et al., 2025).

Prior studies have established the relevance of BIM information requirements in cadastral workflows and the usefulness of IDS for structured BIM validation. However, they have not explored what classes of cadastral admissibility requirements IDS can support, which ones it can only approximate, and which ones remain outside its scope. This gap is important in condominium registration, where submission-stage admissibility depends simultaneously on declarative metadata, legal grouping relations, and geometry-dependent conditions.

To address this research gap, this paper examines IDS not as a general-purpose cadastral solution, but specifically as a submission-stage validation mechanism within a BIM-based condominium registration workflow. The admissibility requirements are derived from the Moroccan condominium legal and technical framework, while an enriched IFC case study provides the empirical basis for analysing IDS performance across directly supported, partially supported (bounded), and unsupported validation scenarios.

3. Cadastral Admissibility Framework

3.1 Admissibility as a workflow concept

In this study, cadastral admissibility is understood as the set of conditions that a submitted BIM model must satisfy before it can enter a BIM-based 3D condominium cadastral workflow. It is distinct from full cadastral validity. The aim is not to determine whether the model already constitutes a legally registrable cadastral record, but whether it contains a sufficiently structured and semantically qualified representation to support downstream transformation, legal interpretation, and complementary validation.

In condominium contexts, this distinction reflects the fact that BIM models are produced primarily for design and construction rather than for cadastral registration. A model may be architecturally detailed while still unsuitable for cadastral processing if legally relevant spaces are not properly represented, identified, or structured. Admissibility is therefore a submission-stage readiness check: it asks whether the model can proceed to cadastral processing, not whether all legal and geometric conditions for registration are already fulfilled. This positioning is aligned with the role IDS plays in other OpenBIM submission workflows (Fischer et al., 2025; buildingSMART International, 2024). Figure 1 illustrates this concept of BIM cadastral admissibility as a submission-stage gateway within the larger BIM-to-cadastre workflow.

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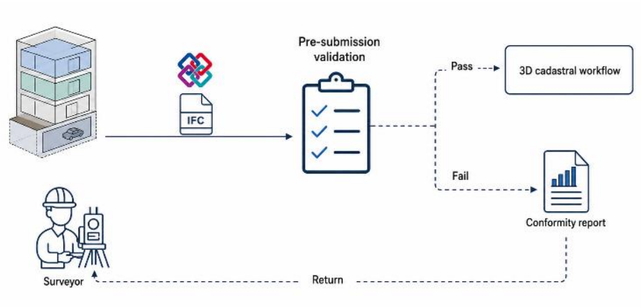

Figure 1. Concept of BIM cadastral admissibility

3.2 Four Requirement Types

The requirements that define cadastral admissibility are not uniform in nature. Treating these requirements as one uniform validation problem hides an important point: they do not rely on the same evidence and cannot be checked with the same mechanism. Prior work on BIM-to-cadastre workflows identified that cadastral use of BIM involves more than geometric conversion. It also requires semantic qualification, legal structuring, relations between entities, and geometry-dependent checks (Oldfield et al., 2017; Stoter et al., 2024; Broekhuizen et al., 2025).

Based on these observations, this paper proposes a four-type decomposition of cadastral admissibility requirements according to the kind of evidence required for validation. The four-type decomposition is proposed as a general analytical framework, while its application here is grounded in the Moroccan condominium context.

Type 1 Structural and semantic adequacy. This type covers the presence and correct qualification of required IFC entities and their attributes. It asks whether IfcSpace and IfcZone instances exist, whether they carry the required property sets, whether attributes are correctly typed and conform to controlled vocabularies, and whether mandatory legal identifiers are present. The evidence required is local and alphanumeric: it can be read directly from the IFC file content without computation or external reference.

Type 2 Relational completeness. This type covers the grouping and aggregation relationships between IFC entities. It asks whether spaces are assigned to legal zones, whether private parts are aggregated into ownership units, and whether the declared relational structure matches the legal hierarchy of the applicable framework. The evidence required is structural: it depends on the presence of IFC relationship entities, such as IfcRelAssignsToGroup and IfcRelAggregates, and on their correct targets.

Type 3 Arithmetic and inter-element consistency. This type covers constraints that require computation across multiple IFC instances. The most significant example in the Moroccan condominium context is the requirement that co-ownership shares expressed as "tantième" values sum to 10,000 across all private parts, as required by Article 6 of Law 18-00 (Royaume du Maroc, 2002). The evidence required is mathematical: it depends on arithmetic operations over multiple elements.

Type 4 Geometric and external validity. This type covers spatial consistency of legal volumes and their correspondence with external institutional records. It asks whether legal space volumes are geometrically closed and non-overlapping, and whether cadastral identifiers declared in the model correspond to records maintained by the registration authority. The evidence required is either computational, for example, through spatial intersection analysis, or institutional, through cross-referencing with external databases.

This decomposition is used throughout the paper to distinguish between requirements that are directly executable in IDS and those that are outside standard IDS 1.0 support. Figure 2 summarizes this four-type decomposition and shows how it relates to the practical scope of IDS 1.0.

Type	Requirement category	Evidence required	IDS 1.0 support	
T1	**Structural and semantic** Are required entities, properties, values present? Are datatypes correct?	**Declared IFC content** Entity type, attribute value, property, datatype, controlled vocabulary, classification.	**Direct** All 6 IDS facets applicable.	IDS is designed for alphanumeric information requirements, including entity, property, attribute, and value checks.
T2	**Relational** Are grouping and aggregation relations correctly declared between IFC entities?	**IFC relationship structure** IfcRelAssignsToGroup, IfcRelAggregates, relation type and declared targets.	**Bounded** partOf facet only.	The partOf facet can verify that an object belongs to an assembly or group. It cannot establish semantic correctness or uniqueness of the relation.
T3	**Arithmetic** Are cross-element values consistent (e.g. totals, sums)?	**Cross-instance computation** Multiple arithmetic operations across multiple IFC values.	**None** No arithmetic facet exists.	IDS is limited to alphanumeric checks on individual elements. It does not support cross-instance arithmetic or aggregate evaluation.
T4	**Geometric and external** Are local volumes spatially valid and aligned with official external records?	**Spatial comparison and external reference** Geometric non-overlap, volume topology, institutional record cross-referencing.	**None** No geometry or external query facet exists.	IDS does not define detailed geometric reasoning and cannot query external institutional records. Comprehensive spatial and institutional validation is required.

Figure 2. Four-type decomposition of cadastral admissibility requirements and IDS 1.0 structural coverage.

4. IDS Testing and Validation Workflow

4.1 Requirement Formalization

The IDS implementation draws on a set of cadastral admissibility requirements derived from the modelling and enrichment framework adopted in this study. Grounded in Law 18-00 and the ANCFCC (National Agency for Land Conservation, Cadastre and Cartography) technical norm, the framework translates Moroccan condominium requirements into concrete IFC modelling decisions: which entities to use, what attributes to set and how to structure the legal groupings. The requirements were first formulated at domain level and then translated into executable validation constraints.

The requirements presented here were selected to cover the four requirement types, including two explicit boundary probes, R7 and R9, used to illustrate the limits of IDS 1.0. These probes include checks on locally declared information, while the broader conditions they represent remain outside executable IDS 1.0 support. Together, they cover five main aspects of BIM submission readiness: building identity, semantic qualification of interior spaces, legal structuring of condominium objects, relational consistency between elementary spaces and legal grouping objects, and advanced cadastral validity conditions. Table 1 summarizes this representative subset and its main IDS translation logic.

4.2 IDS Implementation

Figure 3 summarizes the workflow adopted in this study to transform domain-level admissibility requirements into executable IDS validations and to analyse the resulting outcomes. The workflow links the requirement formalization presented in Section 4.1 to IFC enrichment, IDS specification creation, validation execution with ifctester, and results analysis across supported, bounded, and unsupported cases.

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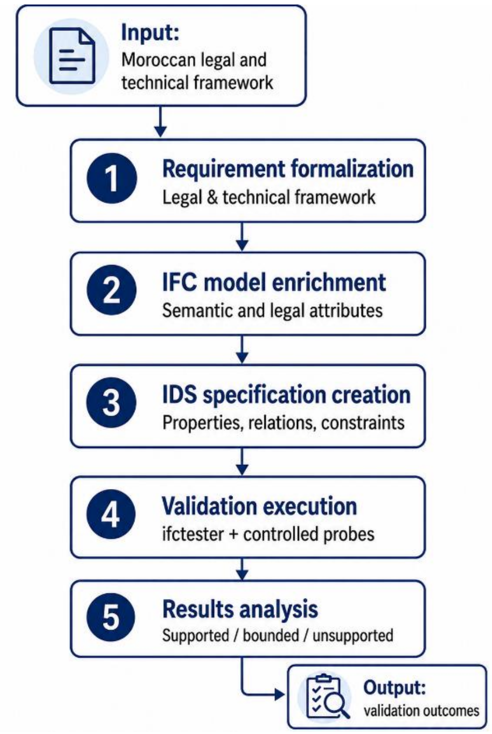


Figure 3. IDS validation workflow adopted in the study.

Following this workflow, the executable validation set was implemented using ifctester, an open-source IDS validation tool distributed as part of IfcOpenShell 0.8.4 (IfcOpenShell Development Team, 2024). The study's contribution lies in deriving and formalizing the admissibility requirements as IDS specifications, while ifctester was used to execute them on the enriched IFC model and the controlled variants. The specifications targeted the IFC entities that play a direct role in the adopted submission logic: IfcBuilding for cadastral identity, IfcSpace for semantic preparation of elementary interior spaces, IfcZone for legal grouping objects, and IfcProjectedCRS for georeferencing metadata. The implementation relied on the enriched IFC structure developed in the study, notably the custom property sets covering building identity, space semantics, and legal zone classification. It also used the representative requirement subset summarized in Table 1.

Beyond direct metadata checks, the evaluation examined how key IDS mechanisms behave in practice, especially conditioned applicability, occurrence constraints, and relation checks through partOf. Two implementation choices are important here. The first was conditioned applicability, used to restrict selected requirements to a semantic subset of IfcSpace objects. The specification applies the PropertyIndex requirement only to private-use spaces identified through declared SpaceUnitFunction values. The applicability filter and the requirement address different properties: SpaceUnitFunction serves as the selection criterion, while PropertyIndex is independently required on the filtered subset. This is how IDS 1.0 approximates conditional logic despite the absence of native if-then support. The second was the partOf facet for relation-based checks, which allowed the validation set to verify that space-to-zone grouping relations had been declared, while leaving open the further question of semantic correctness and uniqueness.

ID	Requirement	Type	IDS logic
R1	Building submission identifies the parent land title.	T1	Property facet; LotNumber and ParentTitle required.
R2	Each space carries a legal name and functional designation.	T1	Property facet; PropertyName and SpaceUnitFunction required; minOccurs=1 prevents a vacuous pass when no IfcSpace is applicable.
R3	Each space is assigned to its legal zone.	T2	partof via IfcRelAssignsToGroup; relation existence is verifiable, but the legal correctness and uniqueness are not enforceable.
R4	Private parts are represented as IfcZone objects with legal class, use, index, and "tantième" .	T1	Applicability on OwnershipType='Private'; LegalObjectClass, LegalObjectUse, PropertyIndex (IfcInteger),Tantieme_1_10000 (IfcReal) required.
R5	Ownership units are represented as IfcZone objects with title and owner identifier.	T1	Applicability on LegalObjectType='OwnershipRight'; PropertyTitle and OwnerID required.
R6	Private parts are aggregated into ownership units.	T2	partof via IfcRelAggregates; aggregation existence is verifiable; uniqueness of the parent ownership-unit assignment is not enforceable.
R7	Private part "tantième" values sum to 10,000.	T3	The presence and datatype of individual share values can be checked, but the cross-instance sum is not expressible in IDS 1.0.
R8	The model specifies a projected coordinate reference system (CRS) through IfcProjectedCRS.	T4	Attribute facet on IfcProjectedCRS.Name ; enumeration (EPSG:26191); minOccurs=1 detects absence. The check verifies the declaration, not its geographic suitability.
R9	Legal space volumes do not overlap.	T4	Local metadata can be checked, but geometric overlap cannot be evaluated in IDS 1.0 and requires external spatial computation.

Table 1. Representative admissibility requirements and IDS translation logic.

Note: The requirement that private-part "tantième" values sum to 10,000 is derived from Article 6 of Law 18-00 (Royaume du Maroc, 2002). EPSG:26191 is the projected CRS code used for the Rabat case study and corresponds to one of the Moroccan national projected CRS definitions (International Association of Oil and Gas Producers, 2002).

Figure 4 shows the R3 specification, which checks that each IfcSpace is assigned to its legal zone.

Figure 5 shows R8, the georeferencing check. The specification targets IfcProjectedCRS through the attribute facet. This IFC entity is used to declare the coordinate reference system, and its Name attribute is constrained to the projected CRS code used for the case study. The minOccurs=1 parameter forces a failure when no IfcProjectedCRS entity is present, making the complete absence of georeferencing metadata detectable.

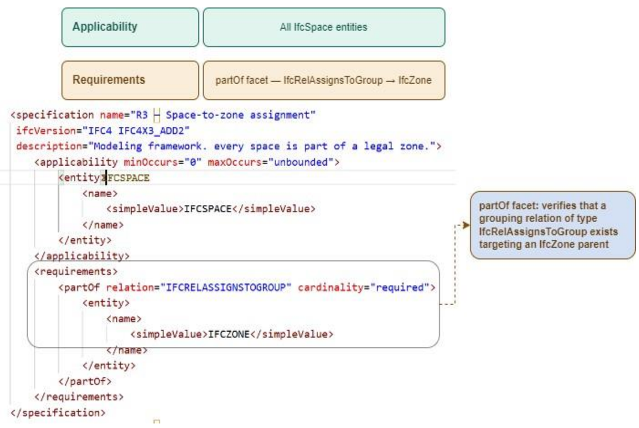


Figure 4. IDS specification for R3: Each IfcSpace must be partOf a legal IfcZone.

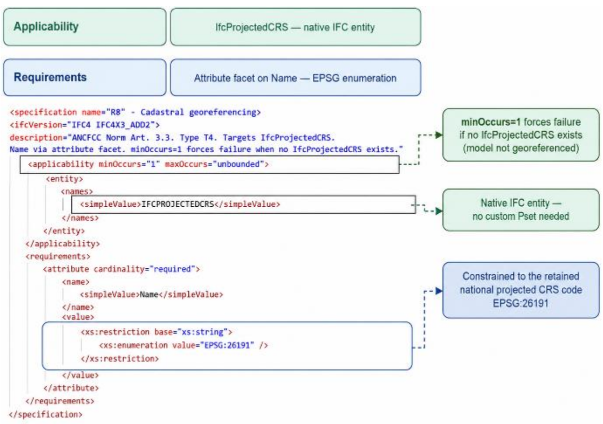


Figure 5. IDS specification R8: IfcProjectedCRS.Name must match the projected CRS code of the case study. minOccurs=1 forces failure when the entity is entirely absent, making the missing georeferencing detectable at submission stage.

4.3 Case Study, Experimental Design, and Validation Workflow

The evaluation combined baseline execution on a real enriched IFC condominium model with a set of controlled perturbation probes targeting specific boundary conditions of IDS 1.0. The baseline test examined whether IDS could detect actual preparation defects in a realistically structured BIM submission. The controlled variants isolated behaviours that would not necessarily emerge from the case study alone, such as vacuous pass, semantically incorrect but structurally valid grouping, and non-unique grouping relations.
The case study model represents a five-story residential condominium building in Rabat, Morocco. The model was authored in Autodesk Revit at Level of Development (LOD) 300 and exported in IFC4X3_ADD2, then enriched according to the adopted legal-semantic structuring framework. No cadastral-specific Model View Definition (MVD) was applied; the required legal-semantic content was added through post-export enrichment. LOD 300 was considered sufficient for the purposes of this study because the validation focus was not detailed construction modelling, but the structured representation of spaces, legal groupings, and associated semantic attributes required for admissibility checking.

The enrichment generated IfcZone instances for private parts, ownership units, and common parts. It also linked IfcSpace instances to legal groupings through IfcRelAssignsToGroup, aggregated ownership units through IfcRelAggregates, and attached the custom property sets required for admissibility checking. After enrichment, the model contained 85 IfcSpace entities, 23 private-part IfcZone entities, 13 ownership-unit IfcZone entities, and 4 common-part IfcZone entities.

The complete IDS test set was executed using ifctester (IfcOpenShell 0.8.4). In parallel, three controlled model variants were generated programmatically with IfcOpenShell to examine behaviours that could not be reliably inferred from the baseline model alone. These variants were treated as targeted probes rather than as additional case studies. Each probe introduced a specific controlled modification while preserving the remaining model structure. Table 2 summarizes the modification applied in each probe and the validation issue examined.

Probe	Controlled modification	Validation issue examined
P1	An empty IFC model was tested using specifications with minOccurs=0 and minOccurs=1.	Vacuous pass and the effect of applicability cardinality.
P2	An IfcSpace was assigned to a semantically incorrect IfcZone while retaining a valid IfcRelAssignsToGroup relation.	Semantic correctness of grouping relations.
P3	The same IfcSpace was assigned to two legal IfcZone objects.	Uniqueness of legal-zone assignment.

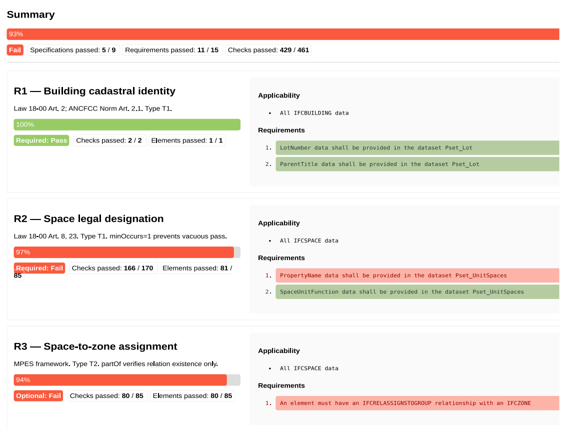
Table 2. Controlled probes used to examine the limits of IDS 1.0

5. Results and Discussion

5.1 Empirical Validation Outcomes

The IDS validation set was executed on the enriched IFC condominium model and the controlled model variants introduced in Section 4.3. The validation produced two types of evidence: results from the nine specifications applied to the baseline model, and observations from three targeted probes used to examine selected limits of IDS 1.0. For R7 and R9, the executable specifications checked only local information because IDS 1.0 cannot evaluate the full arithmetic and geometric conditions. The baseline outcomes are presented first, while the three controlled probes are discussed in Section 5.2. Figure 6 shows representative extracts from the HTML report generated by ifctester. In the ifctester report, 'Required' and 'Optional' indicate the cardinality of each IDS specification: a required specification expects at least one applicable IFC entity, whereas an optional specification permits an empty applicability set. 'Checks passed' refers to the number of successful individual requirement evaluations across the applicable entities, while 'Elements passed' indicates how many applicable IFC entities satisfied all requirements of the specification.

The baseline validation identified multiple defects in a model that had already been intentionally enriched for cadastral use. R1, R5, and R6 passed all specified checks, showing that the required building identity, ownership-unit metadata, and declared aggregation relations were present. R2 and R3 revealed localized gaps: four spaces lacked the required PropertyName value, and five had no declared assignment to a legal zone. R4 failed across all 23 private-part zones because PropertyIndex had been encoded as IfcLabel rather than the required IFCINTEGER. R8 failed because no IfcProjectedCRS entity was present, meaning that the required projected CRS declaration was absent. These baseline outcomes show that IDS-based pre-validation can reveal concrete authoring and enrichment defects before downstream cadastral transformation begins.



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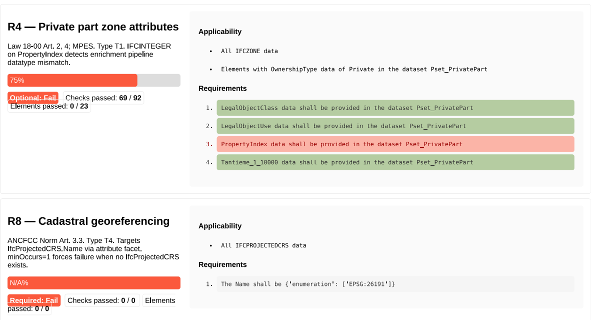

(b)

Figure 6. Representative ifctester validation outputs for the enriched IFC condominium model: (a) overall summary and results for R1–R3; and (b) selected failures for R4 and R8.

5.2 Reliable support: local and declarative admissibility checks

IDS performed most reliably on Type 1 requirements, where admissibility depends on declared entities, property sets, datatypes, and controlled values. In these cases, IDS was an effective and transparent checker. IDS can verify building-level cadastral identity and ownership unit metadata when they are explicitly materialized in the IFC model. R4 failed across all 23 zones, not because information was missing, but because PropertyIndex was stored as IfcLabel instead of IfcInteger. A model may appear complete under visual inspection and still fail because the encoded values do not conform to the expected datatype.

The R2 outcome further shows that IDS can detect localized semantic incompleteness at the level of individual spaces. In the present case, four defective spaces were sufficient to prevent full admissibility under the requirement set, even though the rest of the model was correctly enriched. In BIM-based cadastral workflows, IDS therefore enforces a baseline level of semantic explicitness.

Completeness raises a different issue. The vacuous pass probe P1 showed that a specification with minOccurs=0 passed on an empty model, whereas setting minOccurs=1 caused the specification to fail. Stronger occurrence constraints can therefore prevent vacuous acceptance when no applicable entities are present. However, this does not resolve the broader issue of completeness. Even when a specification correctly fails on total class absence, IDS still cannot determine whether all legally relevant spaces have been modelled. A submission may therefore satisfy minimum occurrence constraints while still omitting required spaces or containing unmodelled portions of the building. IDS can thus enforce minimum existence, but not completeness of the legal-spatial representation. Completeness here refers to the legal-spatial population: whether all private parts, common parts, and ownership units required by the co-ownership regulations are represented in the model. IDS can verify the presence of declared entities; however, it cannot confirm their correspondence with the expected legal decomposition, as such decomposition is defined by the co-ownership deed and floor plans, not by the IFC file itself.

Support is limited for Type 2 requirements. On the baseline model, R3 and R6 show that IDS can verify the existence of declared grouping and aggregation relations. This is already useful in a cadastral submission context, because models with missing zone assignments or missing ownership aggregation can be detected before transformation. However, the controlled probes show that this support is structurally bounded.

Probe P2 showed that the IDS relation check passed when a space was assigned to the wrong legal zone, provided that a formally valid partOf relation exists. Probe P3 showed that the same relation check also passed when a space was assigned simultaneously to two legal zones. In both cases, the validator confirms relation existence, but not the legal-semantic correctness or uniqueness of the assignment. Here, semantic correctness refers to legal domain correctness: whether the zone to which a space is assigned is the zone legally designated to contain it under the co-ownership regulations. This differs from structural correctness, which IDS can verify, and from the correctness of domain classes, which can be approximated using attribute constraints but not entirely enforced. In condominium registration, the existence of a grouping relation is not sufficient evidence that the legal decomposition is correct. A space attached to the wrong private part, or to more than one, may still satisfy the structural expectation of IDS while remaining legally ambiguous or inadmissible.

Additional attribute constraints could strengthen this type of check by restricting the acceptable parent to a zone of the expected semantic category. However, such constraints would still not establish that the related zone is the legally correct parent for the space if multiple candidate zones satisfy the same declared attributes. The limitation therefore concerns semantic identity, not only semantic class.

Standard IDS checking can only partially address relation-based admissibility. IDS can answer the question "is there a declared relation of the expected kind? ", but not the stronger cadastral questions "is this the correct legal parent? " and " is this the only legal parent?". The partOf facet can support structural completeness, but it does not provide legal-semantic certainty.

5.3 Arithmetic, geometric and external reference validation requirements

R7 and R9 were used as boundary requirements to document requirement classes that lie outside standard IDS 1.0 support. For R7, direct inspection outside IDS showed that the sum of Tantieme_1_10000 values across all private parts was 10,206 instead of the legally required 10,000. All individual values were present, yet the aggregate inconsistency remained invisible to IDS. The issue is therefore not missing information, but the inability of IDS 1.0 to compute across multiple instances.

For R9, the limitation is geometric rather than arithmetic. Volumetric non-overlap requires computation on spatial extents rather than the inspection of locally declared alphanumeric content. Standard IDS 1.0 provides no executable mechanism for this class of condition. Checks that depend on institutional registers similarly require information and mechanisms beyond IDS.

R8 failed on the baseline model because no IfcProjectedCRS entity was present, not because IDS is unable to check CRS declarations. In other words, georeferencing occupies an intermediate position: once the relevant IFC entity is explicitly present, IDS can validate the declared CRS value; when the entity is absent, minOccurs=1 correctly turns this absence into a submission failure. Type 4 conditions do not all stand at the same distance from executable IDS support. Declared CRS metadata can be checked, whereas conditions based on geometric validity or institutional correspondence remain outside IDS 1.0 support.

5.4 Implications for BIM-based cadastral submission

For BIM-based cadastral submission, these findings have three main implications.

First, IDS is most useful in BIM-based cadastral workflows as an early-stage admissibility control rather than as a complete cadastral validation solution. IDS is most effective where the aim is to ensure that the submitted model has reached a minimum threshold of explicitness, structuring, and semantic qualification.

Second, the observed limitations can be grouped in three categories: mitigable formulation issues, expressive limits of deployable IDS 1.0, and admissibility conditions whose evidence is fundamentally non-local because it depends on cross-instance computation, geometry, or external institutional reference. The vacuous pass probe belongs to the first category, since stronger occurrence constraints can prevent empty model acceptance. The relation probes belong mainly to the second, since standard IDS can verify relation existence but not legal-semantic correctness or per-entity uniqueness. Arithmetic consistency, geometric non-overlap, and institutional cross-checking belong to the third, since their evidence is not reducible to declared local IFC content.

Third, the results support a layered validation architecture for BIM-based condominium registration. In such an architecture, IDS should be placed at the submission front end, where it can filter structurally and semantically under-prepared models. Complementary mechanisms must then address what IDS cannot operationally decide: arithmetic consistency, geometric validity, legal spatial completeness, and legally authoritative cross-checking. IDS does not replace cadastral validation. Its contribution is to make the first validation layer machine-readable and repeatable, which is especially useful when submission volumes are high.

5.5 Limitations

The results should be interpreted with four limitations in mind. The empirical assessment rests on a single enriched IFC model in one civil-law context, so generalization should be cautious. The transferability of the findings to other legal and institutional settings has not yet been empirically evaluated. Although the four-type decomposition is formulated according to the nature of the evidence required for validation, its completeness and practical applicability in other jurisdictions remain to be tested. The IDS set reflects the specific modelling and enrichment framework adopted here and cannot be applied to other condominium profiles without adaptation. Some observations also depend in part on the particular validator used -ifctester 0.8.4- although the broader distinction between supported, bounded, and unsupported requirement types follows from the declared scope of IDS 1.0 itself. Finally, the study represented several admissibility conditions of clear cadastral importance, particularly arithmetic and geometric ones, as boundary probes rather than executable IDS checks.

A broader practical issue concerns workflow organization. In the approach presented here, the BIM model is assumed to have already undergone the semantic enrichment and legal structuring required for cadastral use before entering the submission-stage validation pipeline. IDS does not add new cadastral content at this stage. Its role is to verify whether that prior enrichment and structuring have been carried out in a sufficiently explicit, consistent, and machine-readable way to support downstream cadastral processing. In practice, this separates upstream BIM preparation from submission-stage admissibility checking. Future work could examine whether this upstream preparation should rely on full enriched BIM models or on simplified cadastral exchange structures derived from them for submission purposes.

6. Conclusion

This paper examined, through a Moroccan condominium case study, the extent to which IDS 1.0 can support submission-stage admissibility checking for BIM models intended for 3D condominium cadastral workflows. The study formalized admissibility requirements through a modelling and enrichment framework, analysed IDS coverage across four requirement types, and evaluated the resulting boundary on an enriched IFC model of a residential condominium building in Rabat.

The study shows that IDS is effective for the declarative layer of admissibility, including checks on entity presence, property sets, datatypes, controlled values, and basic grouping relations. These conditions can be checked by reading the IFC file directly. It can also reveal actual defects in the process of model preparation and enrichment, so its practical value lies not only in formal compliance reporting but also in exposing problems early in the submission chain.

The observed limits do not all have the same origin. Some arise from default evaluation behaviour and can be mitigated through stronger formulation. Others reflect the expressive limits of standard IDS 1.0: relation checks can confirm that a grouping exists, but not that it is semantically correct or legally unique. Arithmetic consistency and geometric non-overlap remain outside executable IDS support and require complementary mechanisms. The boundary observed in this study follows a simpler distinction: some requirements can be verified by reading declared BIM content, whereas others depend on global computation, spatial reasoning, or external legal reference.

IDS is most valuable as a front validation layer within a larger admissibility architecture. It provides a standard-based, machine-readable gate for checking whether a BIM submission meets the minimum level of explicitness, structuring, and semantic qualification required for downstream cadastral use. Its strength lies in making information delivery requirements operational and auditable at the point of submission. Its limitation is that admissibility in a cadastral sense cannot be reduced to declared metadata alone.

Future work may test the proposed admissibility logic on additional case studies and legal contexts, compare IDS behaviour across validator implementations, and integrate complementary arithmetic, completeness, and spatial checks into a broader cadastral submission pipeline.

Data and Code Availability

The IDS specifications and validation scripts developed for this study are available from the corresponding author upon reasonable request. The complete IFC case model is not publicly available because it contains project-specific building information.

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